GEOSTAR™
NAVIGATION

GeoS-1M®

User Manual
Rev.1.1

R&D Center «GeoStar navigation» Ltd.
Moscow, 2010

Table of Contents

1. Abbreviations 8

2. Description 9

2.1. Introduction 9

2.2. Delivery Kit 9

2.3. Specifications 10

2.4. Inputs/outputs 11

2.5. Power 12

2.6. 1 Pulse Per Second (One Second Time Mark) 12

2.7. Communication Ports 13

2.8. Active Antenna Requirements 13

2.9. Data Protocols Supported 13

2.10. FW Settings 18

2.11. Mechanical Data 19

3. Operation 20

3.1. Typical Connection 20

3.2. ON/OFF Control 20

3.3. Recommended PCB Footprint 21

3.4. Summary of Receiver Operation 22

3.4.1 Cold, Warm, Hot Start 23

3.4.2 Serial Ports Settings 23

3.4.3 Modes of Operation 24

3.4.4 Almanacs 25

3.5. Using Connection Board and GeoSDemo® Demo SW 25

3.5.1 Getting Started 25

3.5.2 Receiver Evaluation Using GeoSDemo® 26

3.5.3 How to Get or Load Almanacs 28

3.5.4 How to Store FW Settings to Flash 32

3.5.5 FW Update 33

4. Appendix A. Binary Protocol Description 35

4.1. Output Messages 35

4.1.1 Message Format 35

4.1.2 Message «0x10». Raw measurements 35

4.1.3 Message «0x11». GPS sub-frame data 37

4.1.4 Message «0x12». GLONASS sub-frame data 38

4.1.5 Message «0x13». ECEF coordinates 38

4.1.6 Message «0x20». Geographic coordinates 39

4.1.7 Message «0x21». Current receiver telemetry 40

© R&D Center «Geostar navigation» 2010-12-20

4.1.8 Message «0x22». SVs in view 42
4.1.9 Message «0x3E». Receiver power-up message 42
4.1.10 Message «0x3F». Negative acknowledge 43
4.1.11 Message «0x40». Response to Set initial parameters 43
4.1.12 Message «0x41». Response to Set serial ports parameters 44
4.1.13 Message «0x42». Response to Set receiver operation mode 44
4.1.14 Message «0x43». Response to Set navigation task solution parameters 45
4.1.15 Message «0x44». Response to Set output data rate 45
4.1.16 Message «0x46». Response to Assign data protocol to communication port 45
4.1.17 Message «0x48». Response to Set GPS almanac 46
4.1.18 Message «0x49». Response to Set GLONASS almanac 46
4.1.19 Message «0x4A». Response to Set GPS ephemerides 47
4.1.20 Message «0x4B». Response to Set GLONASS ephemerides 48
4.1.21 Message «0x4C». Response to Set PPS parameters 49
4.1.22 Message «0x4D». Response to Enable/disable SV in position fix 50
4.1.23 Message «0x4E». Response to Enable/disable NMEA messages 50
4.1.24 Message «0x4F». Response to Enable/disable binary messages 51
4.1.25 Message «0x80». Response to Query initial parameters 51
4.1.26 Message «0x81». Response to Query serial ports parameters 51
4.1.27 Message «0x82». Response to Query receiver operation mode 52
4.1.28 Message «0x83». Response to Query navigation task solution parameters 52
4.1.29 Message «0x84». Response to Query output data rate 52
4.1.30 Message «0x86». Response to Query data protocol assignment to communication port 52
4.1.31 Message «0x88». Response to Query GPS almanac 52
4.1.32 Message «0x89». Response to Query GLONASS almanac 52
4.1.33 Message «0x8A». Response to Query GPS ephemerides 53
4.1.34 Message «0x8B». Response to Query GLONASS ephemerides 53
4.1.35 Message «0x8C». Response to Query PPS parameters 53
4.1.36 Message «0x8D». Response to Query enable/disable status of the SV in position fix 53
4.1.37 Message «0x8E». Response to Query enabled NMEA mesaages 53
4.1.38 Message «0x8F». Response to Query enabled binary messages 53
4.1.39 Message «0xC1». Response to Request FW version command 53
4.1.40 Message «0xC2». Response to Restart receiver command 54
4.1.41 Message «0xC3». Response to Store parameters to Flash command 54

4.2. Input Messages 55
4.2.1 Message Format 55
4.2.2 Message «0x40». Set initial parameters 55
4.2.3 Message «0x41». Set serial ports parameters 55
4.2.4 Message «0x42». Set receiver operation mode 55
4.2.5 Message «0x43». Set navigation task solution parameters 56
4.2.6 Message «0x44». Set output data rate 56
4.2.7 Message «0x46». Assign data protocol to communication port 56
4.2.8 Message «0x48». Set GPS almanac 56
4.2.9 Message «0x49». Set GLONASS almanac 56
4.2.10 Message «0x4A». Set GPS ephemerides 56
4.2.11 Message «0x4B». Set GLONASS ephemerides 56
4.2.12 Message «0x4C». Set PPS parameters 57
4.2.13 Message «0x4D». Enable/disable SV in position fix 57

© R&D Center «Geostar navigation» 2010-12-20

4.2.14 Message «0x4E». Enable/disable NMEA messages 57
4.2.15 Message «0x4F». Enable/disable binary messages 57
4.2.16 Message «0x80». Query initial parameters 57
4.2.17 Message «0x81». Query serial ports parameters 57
4.2.18 Message «0x82». Query receiver operation mode 58
4.2.19 Message «0x83». Query navigation task solution parameters 58
4.2.20 Message «0x84». Query output data rate 58
4.2.21 Message «0x86». Query data protocol assignment to communication port 58
4.2.22 Message «0x88». Query GPS almanac 58
4.2.23 Message «0x89». Query GLONASS almanac 59
4.2.24 Message «0x8A». Query GPS ephemerides 59
4.2.25 Message «0x4B». Query GLONASS ephemerides 59
4.2.26 Message «0x8C». Query PPS parameters 59
4.2.27 Message «0x8D». Query enable/disable status of the SV in position fix 60
4.2.28 Message «0x8E». Query enabled NMEA messages 60
4.2.29 Message «0x8F». Query enabled binary messages 60
4.2.30 Message «0xC1». Request FW version 60
4.2.31 Message «0xC2». Restart receiver 61
4.2.32 Message «0xC3». Store parameters to Flash 61

5. Appendix B. NMEA Data Description 62

5.1. GGA: Global Positioning System Fix Data 63

5.2. GLL: Geographic Position - Latitude/Longitude 64

5.3. GSA: GNSS DOP and Active Satellites 64

5.4. GSV: GNSS Satellites in View 65

5.5. RMC: **Recommended Minimum Specific GNSS Data** 66

5.6. VTG: Course Over Ground and Ground Speed 67

5.7. ZDA: Time & Date 67

5.8. SWPROT: Switch to Binary Protocol 68

5.9. SAVEFL: Save Parameters to Flash 68

5.10. CSTART: Cold Start 68

5.11. WSTART: Warm Start 68

5.12. HSTART: Hot Start 68

6. Appendix C. GeoS-1M Connection Board: Summary 69

© R&D Center «Geostar navigation» 2010-12-20

List of Figures

Fig. 1. Outline drawing (dimensions in mm) 19
Fig. 2. Typical connection diagram 20
Fig. 3. ON/OFF control timing 20
Fig. 4. Recommended footprint 21
Fig. 5. Evaluation kit connections 26
Fig. 6. Choosing the way of connection 27
Fig. 7. GeoSDemo® main window displaying binary data 27
Fig. 8. GeoSDemo® main window displaying NMEA data 28
Fig. 9. Selection of «Query GPS almanac» 29
Fig. 10. Displaying the almanac data transmitted by the receiver 29
Fig. 11. Selection of «Set GPS almanac» 30
Fig. 12. «GPS almanac» panel 30
Fig. 13. Selection of GPS almanac file 31
Fig. 14. Displaying almanac download in «Messages» bookmark 31
Fig. 15. Output data rate panel 32
Fig. 16. 1Hz output data rate acknowledgement message 32
Fig. 17. Selecting command «Store parameters to Flash» 32
Fig. 18. Parameters successfully stored acknowledgement message 32
Fig. 19. Browsing the FW file to be downloaded 33
Fig. 20. FW update progressing 33
Fig. 21. File failed message 34
Fig. 22. Downloading fail message 34
Fig. 23. Update complete message 34
Fig. 24. GeoS-1 Connection Board top view 69
Fig. 25. Receiver and Connection Board assembly 70
Fig. 26. Outline dimensions of GeoS-1 Connection Board 71

© R&D Center «Geostar navigation» 2010-12-20

Revision History

#	Updates	Note
Rev.1.1, 2010-12-20		
1	Description of new NMEA messages added to sections 2.9, 3.4.1, 3.4.2, 3.4.4	
2	Sections 5.9, 5.10, 5.11, 5.12 added	
Rev.1.0, 2010-09-21		
1	Table 5 updated	

© R&D Center «Geostar navigation» 2010-12-20

Scope

This document is intended for the users of combined GPS/GLONASS OEM board GeoS-1M. The document contains general description of the receiver, specifications, outline drawings, and guidelines of using the receiver itself and in conjunction with additional evaluation tools.

The document contains three chapters and three Appendixes as follows:

- Chapter 1 : list of the abbreviations used in the document
- Chapter 2 : technical description of the receiver (specifications, interfaces, power, antenna requirements etc.)
- Chapter 3: how to use the receiver
- Appendix A : binary protocol description
- Appendix B: description of NMEA messages
- Appendix C: GeoS-1M Connection Board summary

© R&D Center «Geostar navigation» 2010-12-20

1. Abbreviations

The list of abbreviations used in the document:

C/A:	Coarse Acquisition
DLL:	Delay Locked Loop
DOP:	Dilution Of Precision
DR:	Dead Reckoning
ECEF:	Earth Centered Earth Fixed
FW:	Firmware
ID:	Identifier
LSB:	Least Significant Bit
LNA:	Low Noise Amplifier
MSB:	Most Significant Bit
N/A:	Not Available
NVSRAM:	None-Volatile Static Random Access Memory
PC:	Personal Computer
PCB:	Printed Circuit Board
PLL:	Phase Locked Loop
PVT:	Position, Velocity, Time
RTC:	Real Time Clock
S/N:	Serial Number
SNR:	Signal-to-Noise Ratio
SV:	Space Vehicle
SW:	Software
TTFF:	Time-To-First Fix
UTC:	Universal Time Coordinated

© R&D Center «Geostar navigation» 2010-12-20

2. Description

2.1. Introduction

GeoS-1M is the combined GPS/GLONASS OEM receiver board. Its architecture includes 24 parallel tracking channels and hardware search accelerator engine that provide advanced technical specifications at small form factor and low power consumption. GeoS-1M generates position fix data as well as extended set of auxiliary and raw measurement data using proprietary binary and standard NMEA protocols with output data rate up to 5Hz. In addition to PVT, GeoS-1 outputs one pulse per second signal for precise timing synchronization. Communication ports are two RS232 ports.

GeoS-1M features real “all-in-view” operation, high accuracy, high sensitivity and advanced TTFF in autonomous mode. GeoS-1M operates with L1 C/A code signals of both GPS and GLONASS satellite constellations.

2.2. Delivery Kit

The delivery kit includes following items:

1. GeoS-1M OEM receiver board
2. GeoS-1M Connection Board (by request)
3. Demo PC SW GeoSDemo®; can be downloaded from http://geostar-navigation.com
4. GeoSDemo® User Manual; can be downloaded from http://geostar-navigation.com
5. GeoS-1M User Manual; can be downloaded from http://geostar-navigation.com
6. GPS/GLONASS antenna (by request).

© R&D Center «Geostar navigation» 2010-12-20

2.3. Specifications

The receiver specifications are summarized in Table 1.

Table 1. Receiver specifications

#	Parameter	Value	Notes
1	Number of channels	24	
2	Position accuracy (rms), m • horizontal • altitude	 <3 <5	(1)
3	Velocity accuracy (rms), m/s	<0.05	(1)
4	Time accuracy (3σ), ns	<150	
5	TTFF, s, average • Cold start • Warm start • Hot start • Reacquisition	 <36 <29 <4 <1	(2)
6	Acquisition sensitivity, dBm, cold start	-140	
7	Tracking sensitivity, dBm	-150	
8	Output data rate, Hz	1 or 5	
9	Dynamics • acceleration • jerk	 <3g <1g/s	(3)
10	Maximum velocity, m/s	515	
11	Maximum altitude, m	18000	
12	Interfaces • Dual RS232	 +	
13	1PPS • level • duration, us	 LVTTL 10…2000	
14	Supply voltage, V	3.0….3.6	
15	Backup voltage, V	2.0…3.6	
16	Supply current @3.3V, mA, typical • acquisition • tracking	 115 110	
17	Backup current, uA, typical	10	
18	Size (length x width x height), mm	35.5x33.2x3.8	
19	Weight, g	<10	
20	Operating temperature, ºC	-40…+85	

Notes:

1. Signal level >-130dBm, HDOP<2, VDOP<3
2. Signal level >-130dBm
3. Signal level >-125dBm

© R&D Center «Geostar navigation» 2010-12-20

2.4. Inputs/outputs

Input/output signals are available at PCB edge pads 1…27 listed in Table 2.

Table 2. IO pads list

#	Type	Name	Function
1		GND	Ground
2		GND	Ground
3	Input	ANT	Antenna input
4		GND	Ground
5		GND	Ground
6		GND	Ground
7		GND	Ground
8		GND	Ground
9		GND	Ground
10	Input	+3,3V	Main power 3.3V
11	Input	ON/OFF	Receiver on/off control
12	Input	RX0	Receive data RS232, Port #0
13	Output	TX0	Transmit data RS232, Port #0
14	Input	RX1	Receive data RS232, Port #1
15	Output	TX1	Transmit data RS232, Port #1
16	Output	1PPS	1 Pulse Per Second output
17	Input	VBAT	External backup power
18		GND	Ground
19		RESET	Do not connect
20		GND	Ground
21		+3,3V	Do not connect
22		GND	Ground
23		TDI	Do not connect
24		TCLK	Do not connect
25		TDO	Do not connect
26		TMS	Do not connect
27		GND	Ground

© R&D Center «Geostar navigation» 2010-12-20

IO signals description:

+3.3V:	Main supply voltage VDD=3.3V. Operating range: 3.0…3.6V
ANT:	Antenna input. The receiver provides antenna DC bias voltage (VDD) to this pad
VBAT:	External backup voltage. Operating range: 2.0…3.6V
ON/OFF:	Receiver on/off control. Logic «0» switches receiver off; logic «1» switches receiver on. Connect to VDD if not used
Rx0, Rx1:	Receive data of Port #0 and #1, respectively. Signal level: LVTTL
Tx0, Tx1:	Transmit data of Port #0 and #1, respectively. Signal level: LVTTL
1PPS:	1PPS output. Signal level: LVTTL. Output high/low load current: 2mA max

IO pads 19, 21, 23, 24, 25, 26 are used for debugging and should be left open.

2.5. Power

The receiver requires regulated 3.3V±10% supply voltage with maximum 50mV p-p amplitude ripple; the voltage is applied to pad 10. ON/OFF signal (pad 11) is used for switching receiver on and off: logic «1» (2.4…VDD) turns receiver on, logic «0» (0…0.4V) turns receiver off. If not used, connect to VDD.

External backup battery is connected to pad 17. Operating range is 2.0…3.6V, typical supply current is 10uA.

2.6. 1 Pulse Per Second (One Second Time Mark)

The receiver outputs one second time mark (1PPS, pad 16) with parameters programmable via binary protocol (input message «0x4C») as follows:

- 1PPS enabled/1PPS disabled
- Synchronization time scale: GPS, GLONASS, UTC(USNO), UTC(SU)
- Polarity: positive/negative. When chosen positive, 1PPS rising edge (low-to-high transition) is synchronized to selected time scale; when chosen negative, 1PPS falling edge (high-to-low transition) is synchronized to selected time scale

© R&D Center «Geostar navigation» 2010-12-20

- Duration: 10us…2ms
- Shift: within ±1ms range.

Signal level: LVTTL. Output high/low load current: 2mA max.

2.7. Communication Ports

The receiver has two communication RS232 ports: Port #0 and Port #1.

The parameters of both RS232 ports are programmable as follows:

- Baud rate, bit/s: 4800, 9600, 19200, 38400, 57600, 115200
- Stop bits: 1 or 2
- Parity: no parity, even, odd, always «0», always «1»

These parameters are programmable via binary protocol (input message «0x41»). Default settings for both ports: baud rate 115200, 2 stop bits, no parity.

RS232 signal level: LVTTL. Tx0, Tx1 outputs high/low load current: 2mA max.

2.8. Active Antenna Requirements

The receiver shall be used with active antenna with 10…35dB exceeding gain. Exceeding gain is defined as antenna LNA gain minus RF cable losses. Cable losses depend on its length and type.

The receiver provides antenna power at antenna input pad 3. Antenna supply voltage is VDD (main supply voltage). Maximum antenna supply current is 100mA.

To protect from antenna overcurrent, the receiver has internal current limiting scheme based on resettable fuse. In case of antenna is shorted, this scheme will limit the current to 150…300mA. The receiver will recover normal operation when the cause of overloading is removed.

2.9. Data Protocols Supported

The receiver supports two data protocols: binary (Appendix A) and NMEA (Appendix B). Both protocols are handled simultaneously. Each protocol is assigned to specific receiver communication port. On default, Port #0 handles binary protocol, and Port #1 – NMEA. Assignment between data protocol and the port number can be changed by using specific binary input command (input message «0x46») following which Port #0 will output NMEA data and Port #0 – binary.

© R&D Center «Geostar navigation» 2010-12-20

Output binary protocol gives the user extended navigation, raw measurements, almanacs and ephemerides data. The input entries provide control and setting capabilities. The input data comprise commands, queries, and settings. In addition, binary protocol supports receiver's FW update.

The output binary messages (packets) are divided into following groups:

1. Messages 0x00…0x3F: automatically generated
2. Messages 0x40…0x7F: responses to settings
3. Messages 0x80…0xBF: responses to queries
4. Messages 0xC0…0xFF: responses to commands.

The messages 0x0…0xF are debug data that not avaialble to the user. Messages 0x00…0x1F are masked e.g. can be disabled by using appropriate mask (input message «0x4F»). On default, all automatically generated masked messages are disabled (no output). Messages 0x20…0x3F are unmasked e.g. cannot be disabled. Output messages are summarized in Table 3.

Table 3. The list of output binary messages

Packet ID	Message (packet)
Automatically generated messages	
0x0	Reserved
0x1	Debug data
0x2	Debug data
0x3	Debug data
0x4	Debug data
0x5	Reserved
0x6	Debug data
0x7	Debug data
0x8	Debug data
0x9…0xD	Reserved
0xE	Debug data
0xF	Reserved
0x10	Raw measurements
0x11	GPS sub-frame data
0x12	GLONASS sub-frame data
0x13	ECEF coordinates
0x14…0x1F	Reserved
0x20	Geographic coordinates

© R&D Center «Geostar navigation» 2010-12-20

0x21	Current receiver telemetry
0x22	SVs in view
0x23…0x3D	Reserved
0x3E	Receiver power-up message
0x3F	Negative acknowledge
Responses to settings	
0x40	Response to Set initial parameters
0x41	Response to Set serial ports parameters
0x42	Response to Set receiver operation mode
0x43	Response to Set navigation task solution parameters
0x44	Response to Set output data rate
0x45	Reserved
0x46	Response to Assign data protocol to communication port
0x47	Reserved
0x48	Response to Set GPS almanac
0x49	Response to Set GLONASS almanac
0x4A	Response to Set GPS ephemerides
0x4B	Response to Set GLONASS ephemerides
0x4C	Response to Set PPS parameters
0x4D	Response to Enable/disable SV in position fix
0x4E	Response to Enable/disable NMEA messages
0x4F	Response to Enable/disable binary messages
0x50…0x7F	Reserved
Responses to queries	
0x80	Response to Query initial parameters
0x81	Response to Query serial ports parameters
0x82	Response to Query receiver operation mode
0x83	Response to Query navigation task solution parameters
0x84	Response to Query output data rate
0x85	Reserved
0x86	Response to Query data protocol assignment to communication port
0x87	Reserved
0x88	Response to Query GPS almanac
0x89	Response to Query GLONASS almanac
0x8A	Response to Query GPS ephemerides
0x8B	Response to Query GLONASS ephemerides
0x8C	Response to Query PPS parameters
0x8D	Response to Query enable/disable status of the SV in position fix
0x8E	Response to Query enable NMEA messages

© R&D Center «Geostar navigation» 2010-12-20

0x8F	Response to Query enable binary messages
0x90…0xBF	Reserved
Responses to commands	
0xC0	Response to Change operation mode command(1)
0xC1	Response to Request FW version command
0xC2	Response to Restart receiver command
0xC3	Response to Store parameters to Flash command
0xC4…0xCF	Reserved
0xD0	Response to Erase Flash sector command(1)
0xD1	Response to Write data to Flash command(1)
0xD2	Response to Store Serial Number command(1)
0xD3…0xFF	Reserved

Notes:

1. N/A to the the user

Input messages are summarized in Table 4:

1. Messages 0x00…0x3F: reserved
2. Messages 0x40…0x7F: settings
3. Messages 0x80…0xBF: queries
4. Messages 0xC0…0xFF: commands

Table 4. The list of input binary messages

Packet ID	Message (packet)
Settings	
0x40	Set initial parameters
0x41	Set serial ports parameters
0x42	Set receiver operation mode
0x43	Set navigation task solution parameters
0x44	Set output data rate
0x45	Reserved
0x46	Assign data protocol to communication port
0x47	Reserved
0x48	Set GPS almanac
0x49	Set GLONASS almanac
0x4A	Set GPS ephemerides
0x4B	Set GLONASS ephemerides
0x4C	Set PPS parameters

© R&D Center «Geostar navigation» 2010-12-20

0x4D	Enable/disable SV in position fix
0x4E	Enable/disable NMEA messages
0x4F	Enable/disable binary messages
0x50…0x7F	Reserved
Queries	
0x80	Query initial parameters
0x81	Query serial ports parameters
0x82	Query receiver operation mode
0x83	Query navigation task solution parameters
0x84	Query output data rate
0x85	Reserved
0x86	Query data protocol assignment to communication port
0x87	Reserved
0x88	Query GPS almanac
0x89	Query GLONASS almanac
0x8A	Query GPS ephemerides
0x8B	Query GLONASS ephemerides
0x8C	Query PPS parameters
0x8D	Query enable/disable status of the SV in position fix
0x8E	Query enabled NMEA messages
0x8F	Query enabled binary messages
0x90…0xBF	Reserved
Commands	
0xC0	Change operation mode(1)
0xC1	Request FW version
0xC2	Restart receiver
0xC3	Store parameters to Flash
0xC4…0xCF	Reserved
0xD0	Erase Flash sector(1)
0xD1	Write data to Flash(1)
0xD2	Store Serial Number(1)
0xD3…0xFF	Reserved

Notes:

1. N/A to the the user

For NMEA data protocol, the receiver generates seven standard output messages GGA, GLL, GSA, GSV, RMC, VTG, ZDA, and five proprietary messages SWPROT, SAVEFL, CSTART, WSTART, HSTART. Data format complies with NMEA 0183 v3.01 standard except talker ID (see remark below). Each NMEA message can be disabled by setting relevant mask in binary protocol (input message «0x4E»). On default, GGA, GSA, GSV, RMC messages are enabled, and GLL, VTG, ZDA - disabled. By using

© R&D Center «Geostar navigation» 2010-12-20

input message «0x4E», the talker ID can be set either as NMEA 0183 v3.01 standard specifies («GP», «GN», or «GL» depending on GNSS system used) or always «GP».

Even if talker ID is selected always «GP», NMEA messages data format and structure are kept complying with 0183 v3.01 standard.

Since RS232 channel has limited data throughput, there are limitations of NMEA messages available at receiver output. The Table 5 specifies available NMEA messages and their output rate as a function of baud rate being set.

Table 5. NMEA messages output rate versus RS232 baud rate

Baud rate, bit/s	GGA	RMC	GSA	GSV	VTG	GLL	ZDA
4800	Once a 1s	Once a 1s	Once a 1s	Once a 20s	Once a 1s	Once a 1s	Once a 1s
9600	Once a 1s	Once a 1s	Once a 1s	Once a 10s	Once a 1s	Once a 1s	Once a 1s
19200	Once a 1s	Once a 1s	Once a 1s	Once a 5s	Once a 1s	Once a 1s	Once a 1s
38400	Once a 1s	Once a 1s	Once a 1s	Once a 1s	Once a 1s	Once a 1s	Once a 1s
57600, 115200	As output data rate	As output data rate	As output data rate	Once a 1s	As output data rate	As output data rate	Once a 1s

Example: if baud rate 4800bit/s is set then GGA, RMC, GSA, GLL, and ZDA messages will be output once a 1 second; GSV message will be output once a 20 seconds.

2.10. FW Settings

The receiver's FW has a number of settings (Table 6) that can be programmed over binary protocol. Default values are programmed during receiver manufacturing. To restore default settings, binary message «0xC2» is used.

Table 6. FW settings

#	Setting	Value on default
1	Mode (GPS only, GLONASS only, GLONASS+GPS)	GLONASS +GPS
2	2D	enabled
3	Coordinates hold	no
4	Dead reckoning (DR)	enabled
5	DR duration	5s
6	Dynamic filtering	on

© R&D Center «Geostar navigation» 2010-12-20

7	Output data rate	1Hz
8	RS232 parameters(for both ports)	115200, 2 stop bits, no parity
9	Assignment of data protocol to communication port	Port #0: binary; Port #1: NMEA
10	GDOP mask	15
11	Elevation mask	5°
12	1PPS parameters	Enabled, polarity: positive, sync to GPS, duration: 1ms, shift: 0ns
13	NMEA messages	GGA, GSA, GSV, RMC: enabled VTG, GLL, ZDA: disabled Talker ID: «GP»
14	Automatically generated masked messages	disabled

2.11. Mechanical Data

The receiver is the PCB assembly with components mounted on single sides and covered by shielding case. The board dimensions (mm): 35.5 (length), 33.2 (width), 3.8 (height). Outline drawing is depicted in Fig. 1.

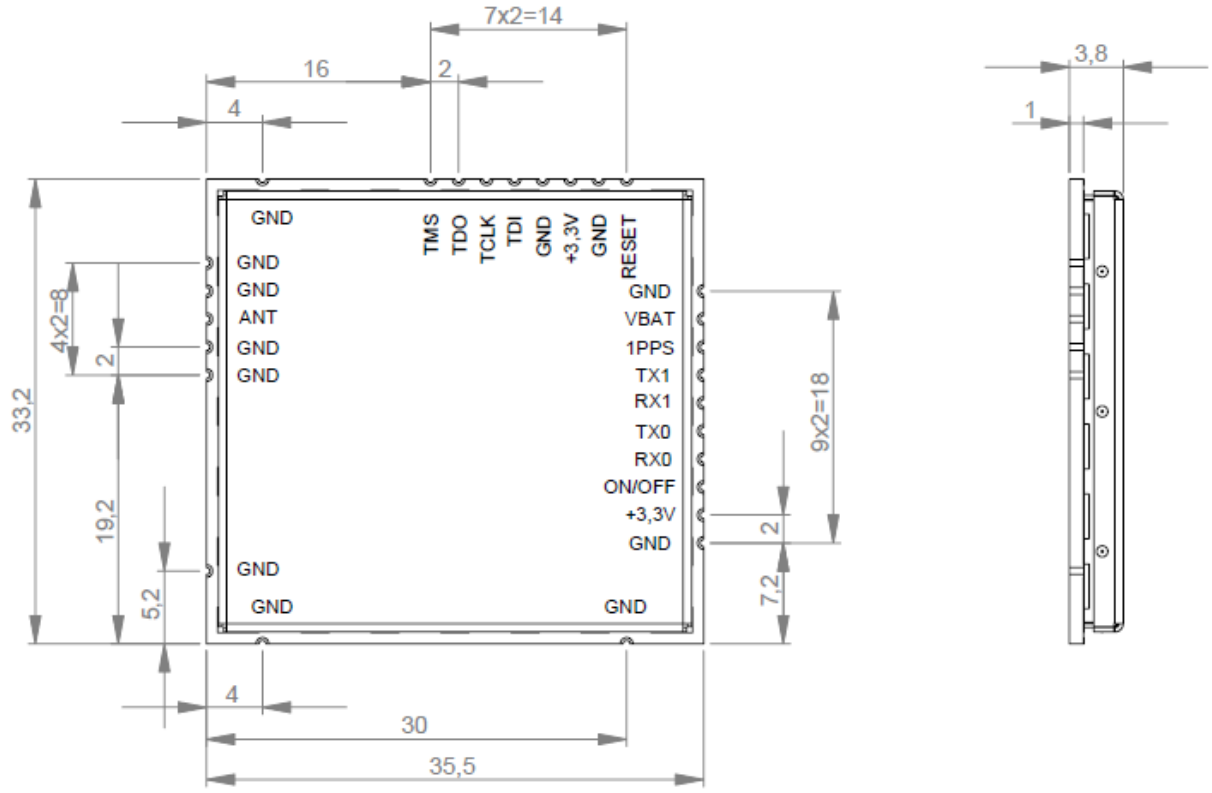


Fig. 1. Outline drawing (dimensions in mm)

© R&D Center «Geostar navigation» 2010-12-20

3. Operation

3.1. Typical Connection

Typical connection diagram is shown in Fig. 2.

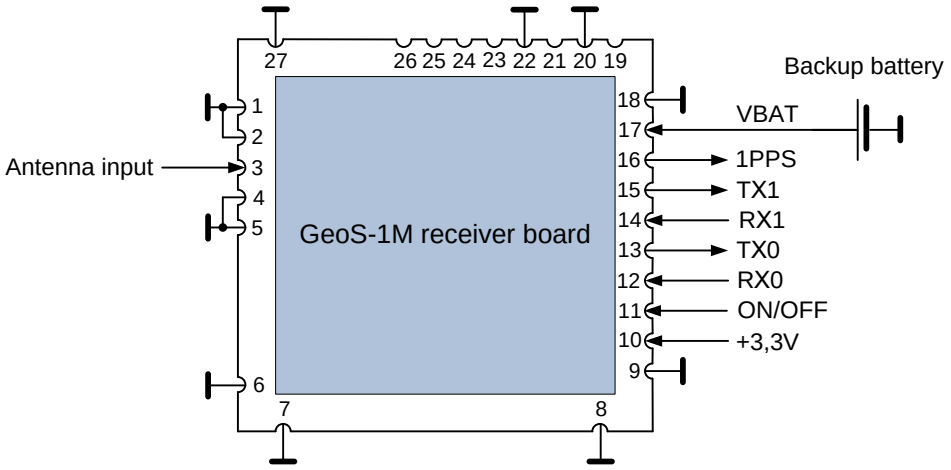


Fig. 2. Typical connection diagram

Main supply voltage VDD is applied to pad 10. ON/OFF (pad 11) is used for power on/off control. External backup battery voltage is applied to pad 17.

3.2. ON/OFF Control

For proper receiver power-on, ON/OFF signal should go high after main supply voltage VDD reaches low operating limit of 3.0V (Fig. 3).

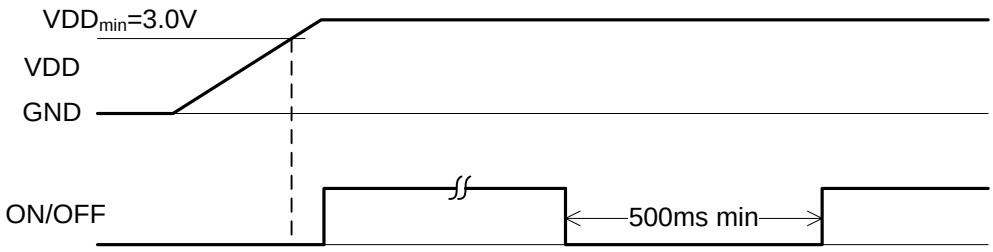


Fig. 3. ON/OFF control timing

Further power-on/off control (if VDD keeps stable and applied to the receiver) could be done using ON/OFF pin as follows:

© R&D Center «Geostar navigation» 2010-12-20

- High-to-low transition switches the receiver off immediately
- Low-to-high transition should be asserted with delay at least 500ms relatively to high-to-low transition.

If not used, ON/OFF should be connected with VDD.

3.3. Recommended PCB Footprint

Recommended footprint is shown in Fig. 4. All dimensions are in mm.

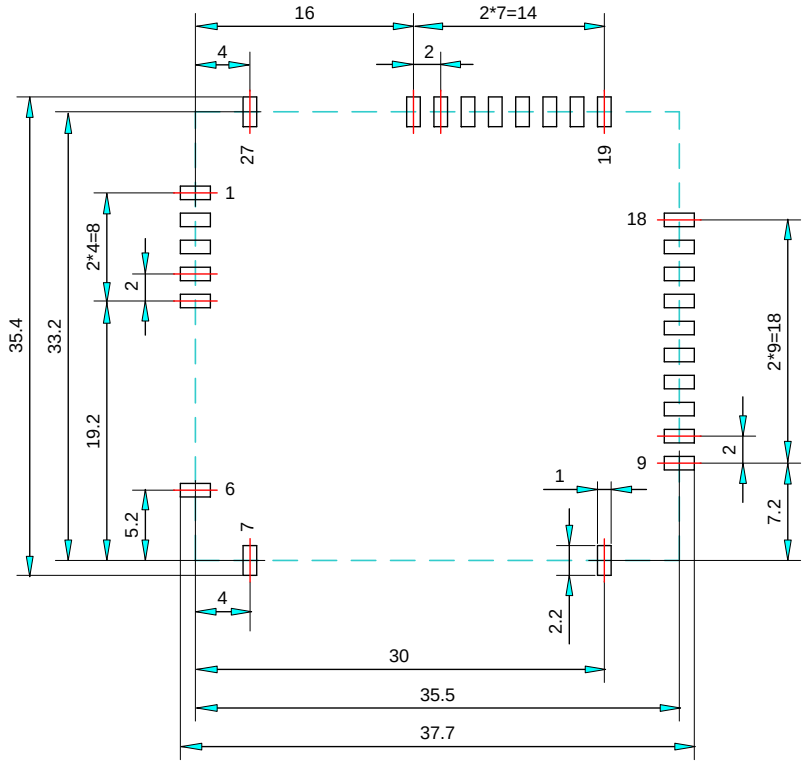


Fig. 4. Recommended footprint

Guidelines on PCB layout:

1. Antenna input should be routed to pad 3 ising microstrip lines with impedance as close as possible to 50 Ohm.
2. Pads 1, 2, 4 и 5 should be connected to PCB ground with shortest lines.
3. Other signal lines should be moved away from antenna input as far as possible. Avoid routing signal lines beneath receiver board.

© R&D Center «Geostar navigation» 2010-12-20

3.4. Summary of Receiver Operation

After receiver is switched on, it starts to operate and output navigation data automatically. On default, Port #0 outputs binary data and Port #1 – NMEA data. During operation receiver periodically outputs following hardware telemetry bits in binary message «0x21» (Receiver status word): antenna status (bit 22), lock of frequency synthesizer (bit 23), receiver identifier (bit 27). Receiver FW version and serial number can be read out in binary message «0xC1» by sending relevant query in binary protocol.

Position fix data (PVT) is available on both data protocols. Receiver generates both protocols simultaneously. Binary output gives the user extended navigation information while NMEA provides seven standard messages. Receiver control as well as FW update is accomplished via binary protocol. After start, until no valid position fix available, the receiver outputs null GGA, GSV, GSA messages. If after successive position fix the signals (and position fix as well) are lost, the receiver transmits in NMEA messages last valid coordinates. Then the «GPS quality indicator» bit field in GGA message is filled with «0» (fix not available or invalid).

After applying power to the receiver, 1PPS signal is not generated until PVT is available and valid. During this controlling 1PPS parameters via binary protocol is disabled (has no effect). Once position fix calculated is valid, 1PPS becomes accurate and synchronous with selected time scale. If signals lost then 1PPS keeps being at receiver output but its accuracy will directly depend on receiver clock drift. There is a 1PPS status data (1PPS valid or invalid) to distinguish whether 1PPS is under control or not (refer to output message «0x21», bit 10 of Receiver status word). Note that the receiver FW doesn't account RF antenna cable propagation delay. Thus, antenna and cable sub-system will add extra delay in 1PPS output. This delay can be compensated by entering 1PPS offset in relevant message in binary protocol (input message «0x4C»). By using this message, user can also set different 1PPS parameters.

Receiver FW features several programmable settings listed in Table 6. Those setting are programmable via binary protocol. Once settings data is released and sent to the receiver, it is buffered in NVSRAM and taken into effect so the receiver will operate with those settings. After removing main power from the receiver, actual settings keep retained in NVSRAM and will be used at next receiver power-up. In case of backup power failure the settings loaded in backup memory are rejected and taken from Flash. If settings in Flash are invalid then default settings (see relevant column in Table 6) will take effect.

The current (actual) settings can be saved in Flash memory by using dedicated binary input message «0xC3» or NMEA message SAVEFL.

© R&D Center «Geostar navigation» 2010-12-20

Sending «0xC3» or SAVEFL message saves to Flash both actual FW settings and satellite almanacs.

Saving FW settings and almanacs takes approximately 1…2 seconds.

The receiver can be configured with default settings by releasing the input message «0xC2». After releasing this message, default settings will take effect and become actual.

3.4.1 Cold, Warm, Hot Start

Depending on availability of approximate position and time, almanacs and ephemeris data, after applying power receiver begins to operate in cold, warm, or hot start. Cold start assumes no valid position, time and almanacs data is available. Thus cold start takes more time. Warm start assumes the approximate position and time and valid almanacs are available. For hot start, it is supposed that position and time as well as almanacs and ephemeris data are available thus the receiver takes less time in this kind of start.

The user can restart receiver in different start modes as follows:

- By using binary input message «0xC2»: sending «0» causes hot start, «1» – warm start, «3» – cold start
- By using NMEA message SAVEFL.

To accelerate signals acquisition, the receiver can be provided with initializing data including: UTC, ECEF XYZ coordinates, clock drift, and GPS-GLONASS time shift. The data should be entered via binary input message «0x40».

3.4.2 Serial Ports Settings

On default, Port #0 outputs binary protocol data, and Port #1 – NMEA. This assignment can be changed by two ways:

- In binary protocol: using «0x46» message
- In NMEA protocol: using SWPROT message.

Note that switching data protocols does not lead to receiver restart.

Both RS232 ports have following parameters on default: 115200bit/s baud rate, 2 stop bits, no parity. Using «0x41» binary message, those parameters could be changed. After sending «0x41»

© R&D Center «Geostar navigation» 2010-12-20

message, new RS232 ports parameters will take effect after receiver program restart («0xC2» binary message or CSTART, WSTART, HSTART NMEA messages) either recycling power.

Since new RS232 ports parameters which set by «0x41» message are buffered in NVSRAM, «0xC3» binary message or SAVEFL NMEA message should be released to store them in Flash.

3.4.3 Modes of Operation

The receiver can operate on different satellite constellations including: GPS only, GLONASS only, GPS+GLONASS (default) which could be set by input message «0x42». Output data rat could be 1Hz either 5Hz (set by input message «0x44»). The receiver operates in 3D (default) or 2D modes. The receiver enters 2D mode if the number of satellites is not enough for 3D solution (if this allowed in message «0x42»).

If enabled, the receiver can extrapolate coordinates if signals were lost and the number of SV is not enough to solve navigation solution in normal way. This mode is called Dead Reckoning. DR duration is programmable within 1…5 seconds range. Programming DR is performed via binary input message «0x43».

The receiver can operate in coordinates hold mode which could be set by message «0x42». In this mode, the receiver utilizes XYZ ECEF coordinates entered as initializing data in message «0x40» and calculates time, clock offset, and clock drift in order to generate accurate 1PPS output. This mode can be used particularly for timing applications. Note that in this mode the 1PPS accuracy will directly depend on initial XYZ coordinates accuracy.

There is «GPS Quality indicator» field in GGA message which could take following values:

- «0» if fix not available or invalid
- «1» if fix valid
- «6» if the receiver operates in DR mode
- «7» if the receiver operates in coordinates hold mode.

Messages GLL, RMC, VTG contain «Mode Indicator» field that could be set to:

- «A» in normal (autonomous) mode
- «E» in DR mode

© R&D Center «Geostar navigation» 2010-12-20

- «M» in coordinates hold mode.

Messages GLL and RMC contain field «Status» that could be set to:

- «A» (data valid) if «Mode Indicator» field has been set to «A»
- «V» (data not valid) if «Mode Indicator» field has been set to «E», «M», or «N».

The receiver utilizes two navigation task parameters as follows: DOP mask and elevation angle mask (input message «0x43»). If DOP that has been calculated is more than DOP mask, the PVT output is disabled. SVs which elevation angle is more than relevant mask are not included in navigation solution. In addition, any SV can be excluded from navigation task solution by using dedicated binary message «0x4D». After power off/on recycling, disabled SVs are restored i.e. allowed to be used in position fix calculation.

3.4.4 Almanacs

Actual GPS/GLONASS almanac is loaded to the receiver's Flash memory during manufacturing. During operation the receiver collects new almanacs and periodically stores them to internal Flash memory. The almanacs can be downloaded to the receiver manually by using binary messages «0x48» for GPS and «0x49» for GLONASS. While downloaded, the almanacs are buffered in receiver memory and the command «0xC3» *or* *SAVEFL* should be released for saving them into Flash memory. In addition, the current almanacs stored in the receiver can be read out from the receiver by sending binary requests «0x88» for GPS and «0x89» for GLONASS.

Note that commands «0xC3» and SAVEFL activate storing to Flash both FW settings and satellites almanacs.

3.5. Using Connection Board and GeoSDemo® Demo SW

3.5.1 Getting Started

The receiver evaluation kit includes Connection Board and GeoSDemo® demonstaration SW. Connection Board provides hardware connection of the receiver to external equipment (power supply, computer, and antenna). Refer to Appendix C for brief Connection Board description.

© R&D Center «Geostar navigation» 2010-12-20

The AC-DC adapter used as a source of DC supply voltage should meet following specifications: 5…30V DC output voltage and 100mA minimum load current. Two serial cables «DB9 male – DB9 female» are used for serial port connections.

Fig. 5 depicts evaluation kit connections.

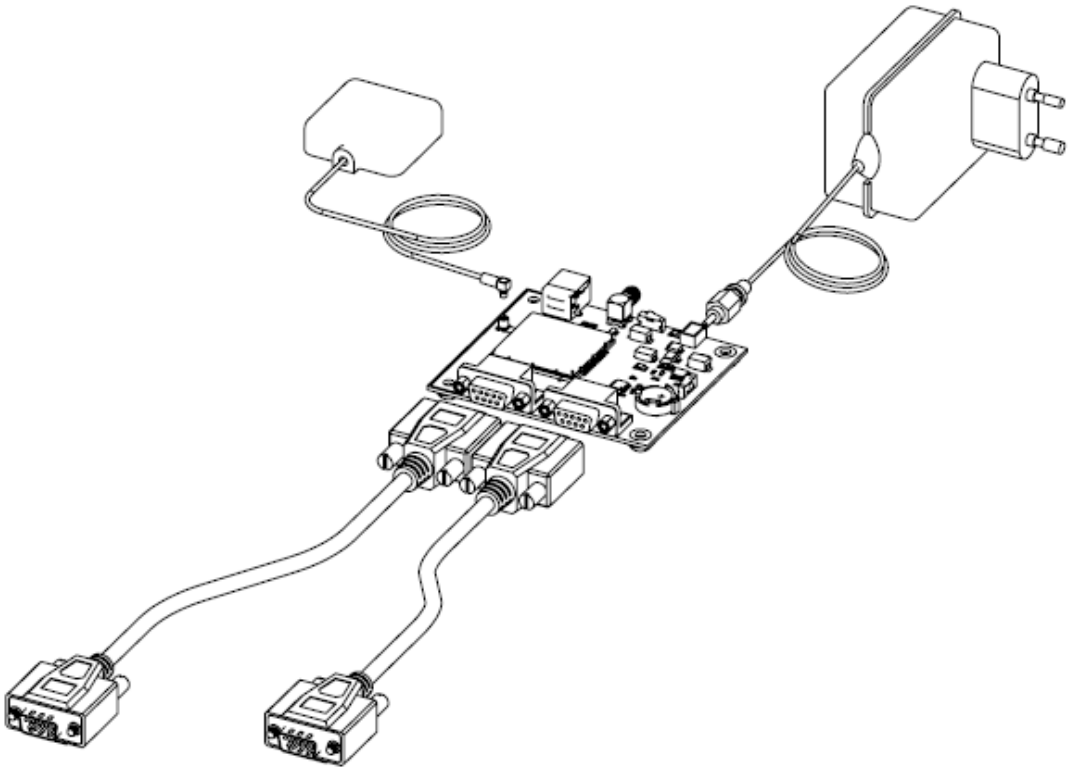


Fig. 5. Evaluation kit connections

Connection Board should be configured as follows:

- Set «Vin» slider to the direction of X2 connector
- Set «Battery» slider to «On».

Demo SW GeoSDemo® should be installed on PC. Refer to GeoSDemo® User Manual for detailed guidelines on the program operation.

3.5.2 Receiver Evaluation Using GeoSDemo®

Please make following connections (make sure the receiver power is switched off):

- Attach AC/DC adaptor and computer COM ports to Connection Board
- Attach GPS/GLONASS antenna to the receiver board.

© R&D Center «Geostar navigation» 2010-12-20

Turn the power on. LED «3.3V» will light up. LED indicators «Tx0» and «Tx1» will blink according to the receiver output data rate. LED «Rx0» will blink only during sending data to the receiver from PC. LED «Rx1» will not light at all.

Run GeoSDemo®. After language selection, choose the way of connection. If the receiver is connected to the computer for the first time, choose «**Detect COM ports automatically**» (Fig. 6).

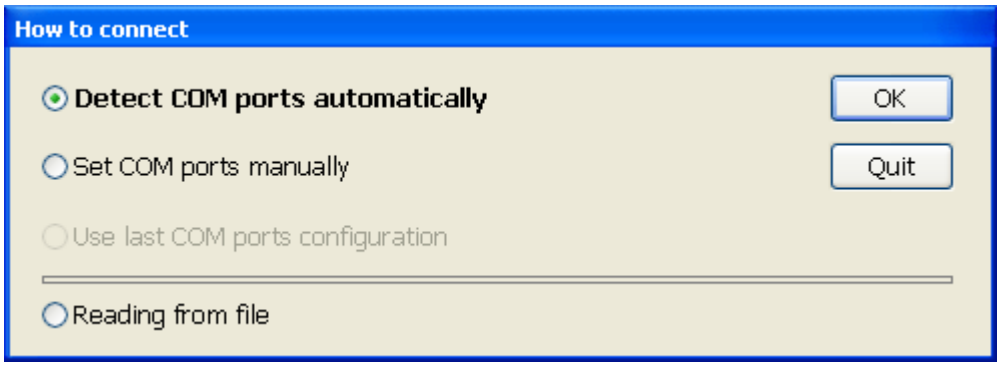


Fig. 6. Choosing the way of connection

For further connections, choose «**Use last COM ports configuration**» provided that the computer COM ports have been kept the same as previously used.

GeoSDemo® communicates with the receiver on both binary and NMEA protocols. Fig. 7 shows the view of main window when working with binary data.

Main window headline presents FW version and data (FW v1.0_2010.02.27) and receiver serial number (N/A: not available) as well.

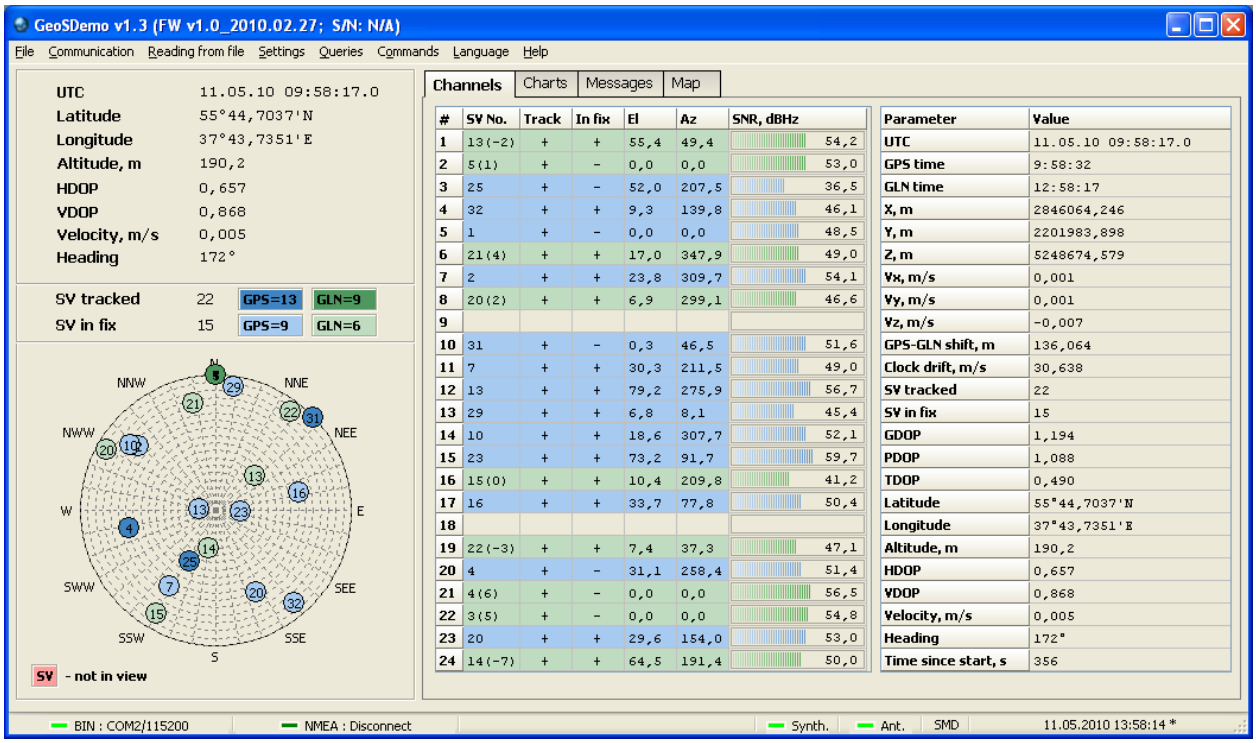


Fig. 7. GeoSDemo® main window displaying binary data

© R&D Center «Geostar navigation» 2010-12-20

Status bar shows:

- COM number and baud rate on binary data (BIN: COM2/115200)
- COM number and baud rate on NMEA data (NMEA: Disconnect)
- Frequency synthesizer telemetry bit «**Synth.**» (green if OK)
- Antenna telemetry bit «**Ant.**» (green if OK)
- Receiver identifier (SMD for GeoS-1M)
- Date/time.

If communication with the receiver is accomplished via NMEA protocol only (binary data is not available) then GeoSDemo® displays NMEA data as shown in Fig. 8. Because NMEA protocol carries less data than binary one therefore some fields of GeoSDemo® windows will be empty.

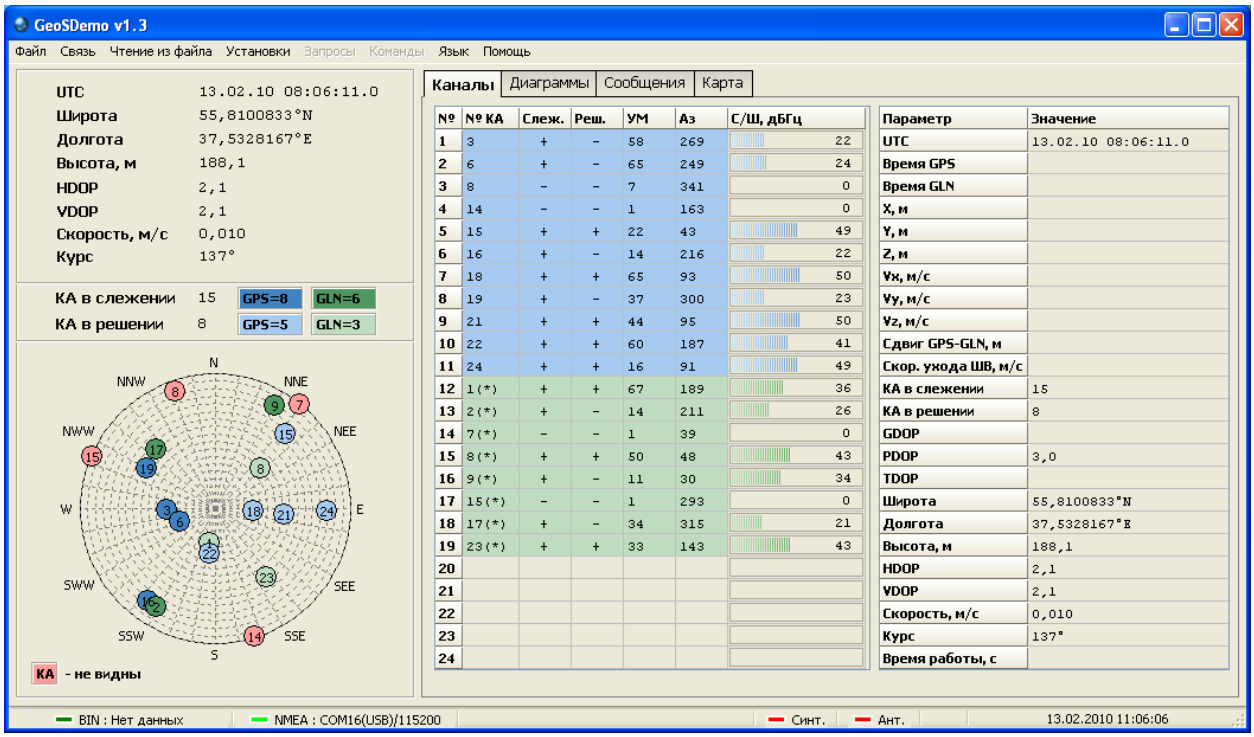


Fig. 8. GeoSDemo® main window displaying NMEA data

Refer to GeoSDemo® User Manual for detailed guidelines on using the program.

3.5.3 How to Get or Load Almanacs

The procedures below describe how to get satellite almanacs from the receiver and how to load them to the receiver (the example presents GPS; similar approach is applicable to GLONASS).

© R&D Center «Geostar navigation» 2010-12-20

To get almanac, please select «**Queries**» → «**Query GPS almanac**» (Fig. 9). The relevant request will be sent to the receiver.

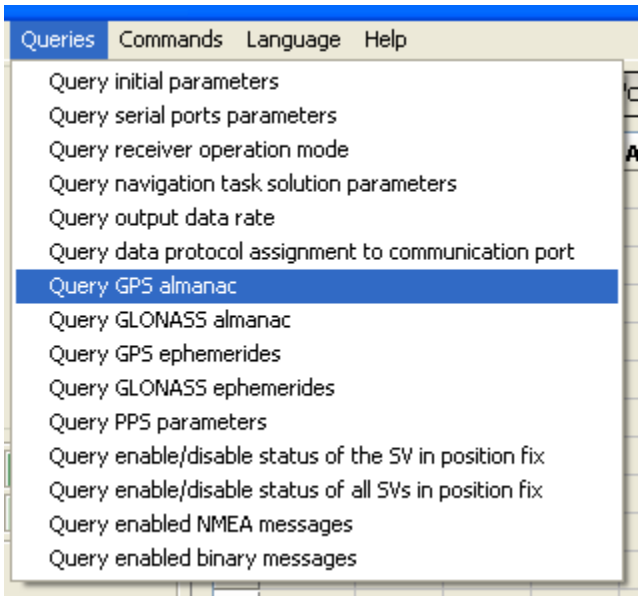


Fig. 9. Selection of «**Query GPS almanac**»

As a response, the receiver will send back the almanac data. Transmitting almanacs are displaying in the upper sub-window of «**Messages**» bookmark (Fig. 10). The program will save almanac automatically in program root directory to «Geostar - Navigation Ltd\GeoSDemo\data\gps» folder.

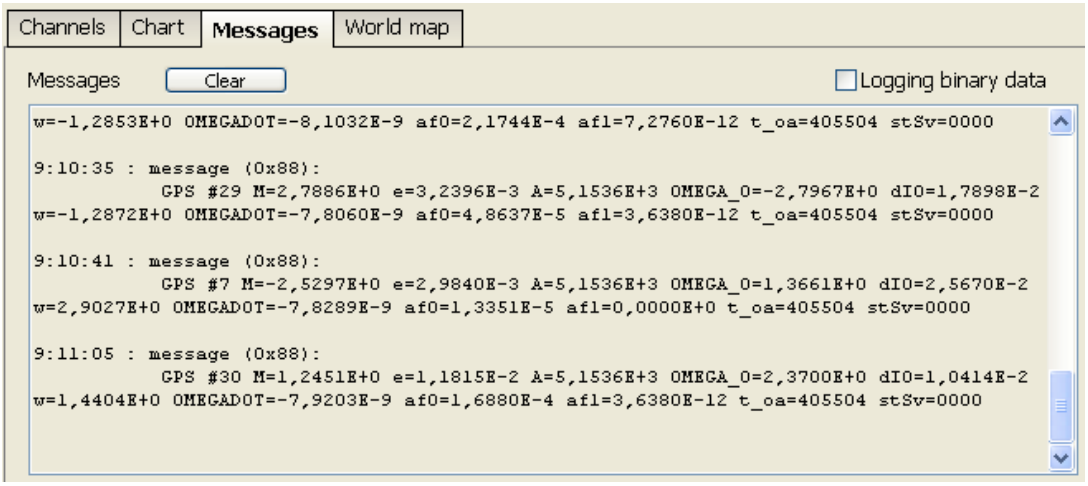


Fig. 10. Displaying the almanac data transmitted by the receiver

To load almanac, please select «**Settings**» → «**Set GPS almanac**» (Fig. 11).

© R&D Center «Geostar navigation» 2010-12-20

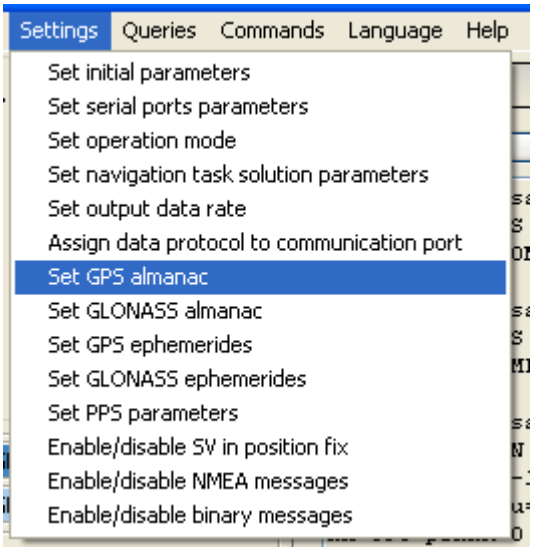


Fig. 11. Selection of «**Set GPS almanac**»

This operation will open aux panel «**GPS almanac**» (Fig. 12) where the almanac file location should be chosen. It is assumed that the almanac has been already received by the receiver and saved by GeoSDemo® program.

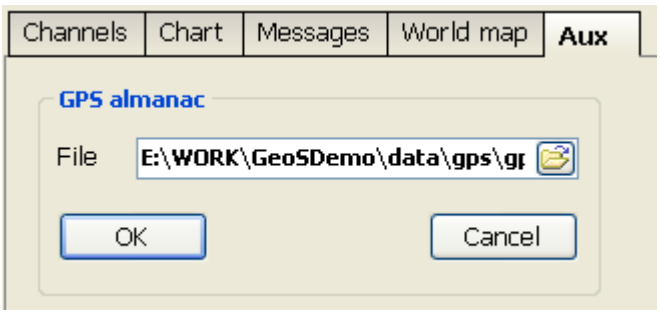


Fig. 12. «**GPS almanac**» panel

Fig. 13 illustrates selection of almanac file in «Geostar - Navigation Ltd\GeoSDemo\data\gps» folder.

© R&D Center «Geostar navigation» 2010-12-20

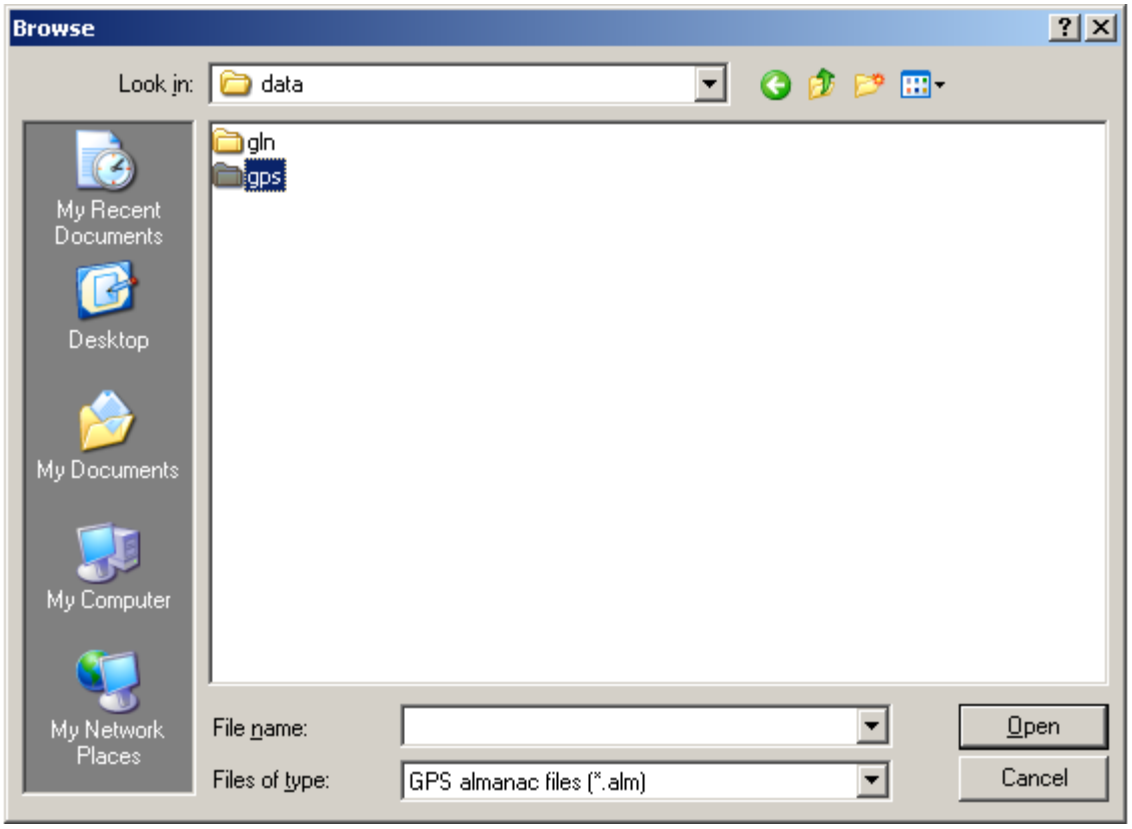


Fig. 13. Selection of GPS almanac file

After file selection, press «**OK**» in «**GPS almanac**» panel. GPS almanac will be dowloaded to the receiver. The process of downloading will be displayed in the upper sub-window in «**Messages**» bookmark (Fig. 14).

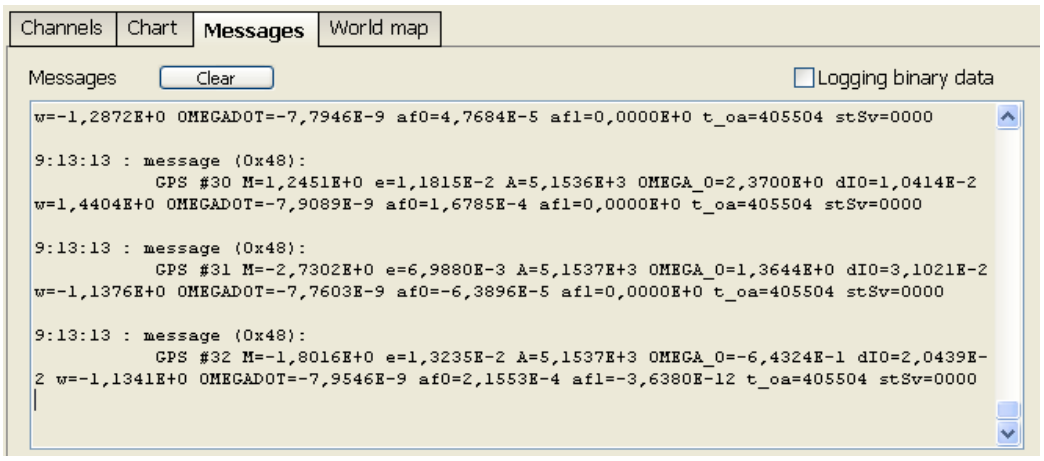


Fig. 14. Displaying almanac download in «**Messages**» bookmark

© R&D Center «Geostar navigation» 2010-12-20

3.5.4 How to Store FW Settings to Flash

The example provided below describes how to change receiver FW settings and store them to the receiver's Flash memory. This particular example describes changing output data rate from 5Hz to 1Hz however the approach is applicable to any FW setting.

Please select «**Settings**» → «**Set output data rate**» in menu. In aux panel (Fig. 15) select 1Hz then press «**OK**».

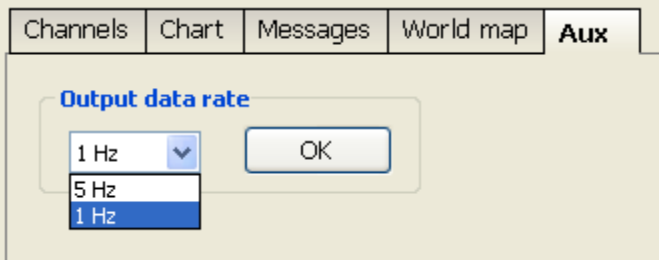


Fig. 15. Output data rate panel

Upper sub-window in «**Messages**» bookmark will display acknowledgement message (Fig. 16).

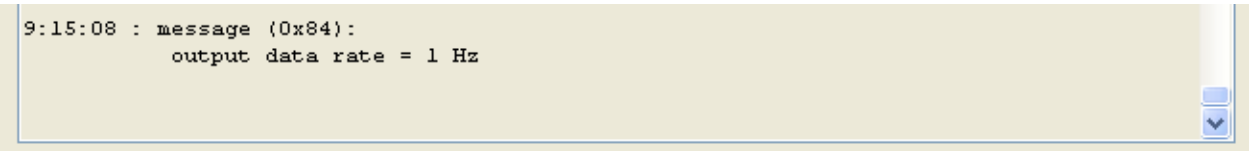


Fig. 16. 1Hz output data rate acknowledgement message

To store this setting, please select «**Commands**» → «**Store parameters to Flash**» in menu (Fig. 17).

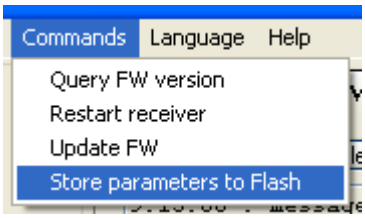


Fig. 17. Selecting command «**Store parameters to Flash**»

If parameters have been stored to Flash successfully then following acknowledgement message will appear (Fig. 18).

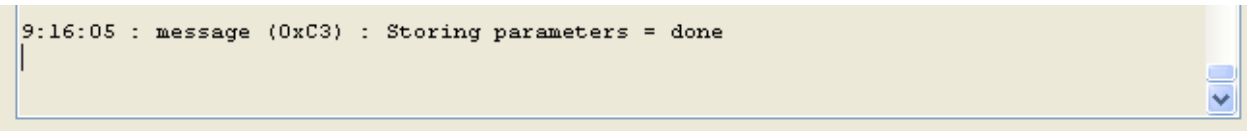


Fig. 18. Parameters successfully stored acknowledgement message

© R&D Center «Geostar navigation» 2010-12-20

3.5.5 FW Update

GeoSDemo® SW is capable to handle receiver FW update via receiver's communication port which is working on binary protocol.

Attach the receiver to Connection Board, apply power and switch the receiver on. Run GeoSDemo® and establish communication with the receiver. In menu «**Commands**» select «**Update FW**» and browse the file to be downloaded in aux panel (Fig. 19). The file should have extension *.bin.

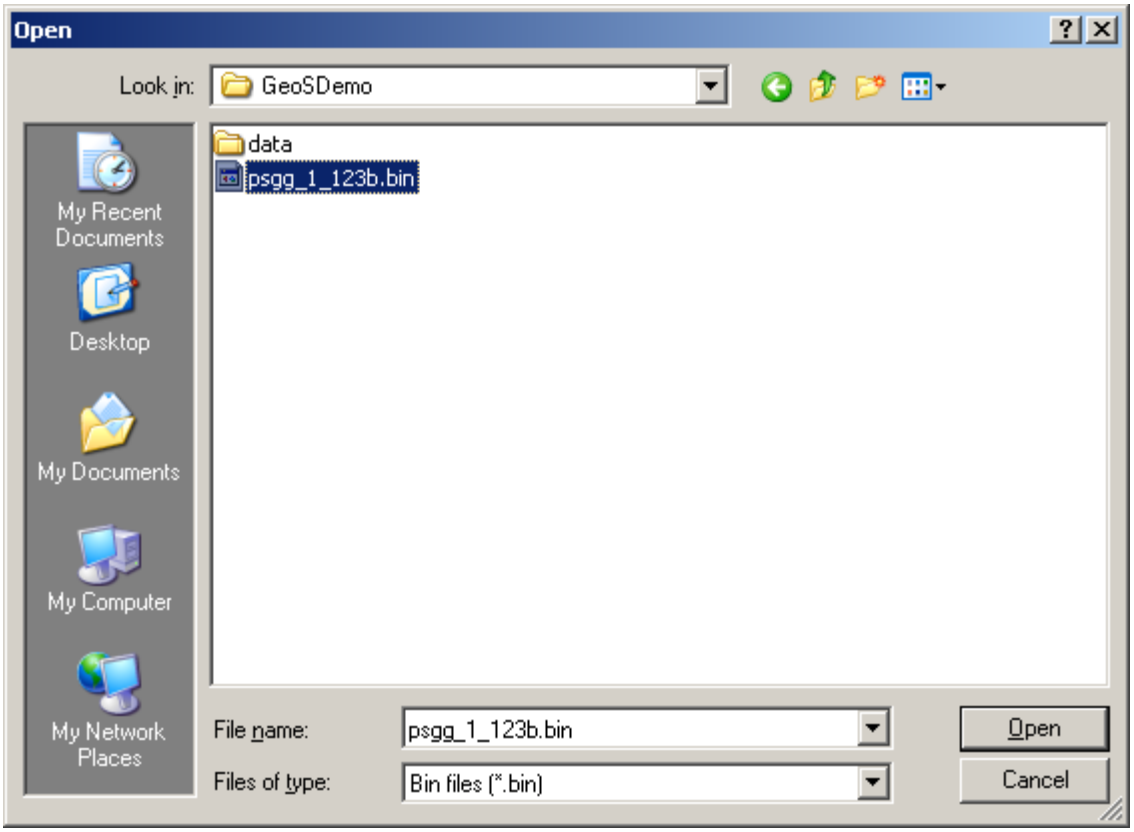


Fig. 19. Browsing the FW file to be downloaded

If the file to be loaded is correct, then the program will start downloading as shown in Fig. 20.

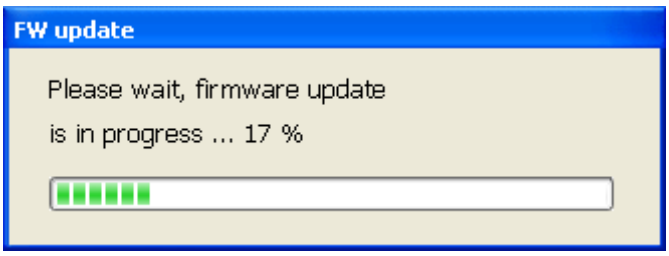


Fig. 20. FW update progressing

If the file that has been chosen is incorrect or failed, then the program will generate the following message (Fig. 21).

© R&D Center «Geostar navigation» 2010-12-20

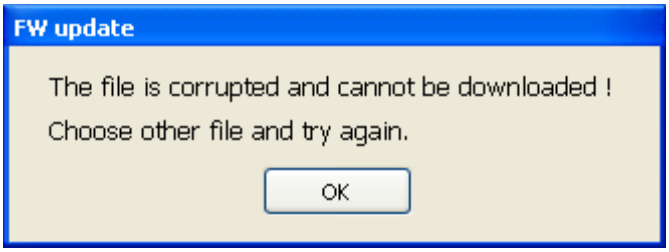


Fig. 21. File failed message

If the error occurred while downloading, then the program will generate the following message (Fig. 22).

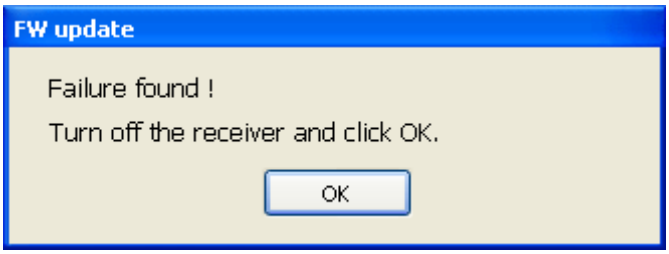


Fig. 22. Downloading fail message

If update has been finished successfully, then following message will appear (Fig. 23).

Fig. 23. Update complete message

Switch off the receiver and click «**OK**» to quit the program. Further receiver evaluation can be done in regular manner.

© R&D Center «Geostar navigation» 2010-12-20

4. Appendix A. Binary Protocol Description

4.1. Output Messages

4.1.1 Message Format

“P”:8 “S”:8 “G”:8 “G”:8 <ncmd:16> <ndat:16> <dat1:32, …, datN:32> <cs:32>

- “PSGG”: message preamble (32 bits)
- <ncmd>: message number (16 bits)
- <ndat>: the number of 32-bit words in data fields (16 bits)
- <dat1, dat2, …, datN>: data fields (32-bit words); the number of words is defined by <ndat> parameter
- <cs>: check sum (32 bits); calculated as exclusive OR of all data fields.

Table 7 presents description of data types.

Table 7. Data types

Type	Description	Length (32-bit words)
byte	Unsigned integer, 8 bit	1/4
short	Signed integer, 16 bit	1/2
u_short	Unsigned integer, 16 bit	1/2
int	Signed integer, 32 bit	1
u_int	Unsigned integer, 32 bit	1
float	Signed real, 32 bit	1
double	Signed real, 64 bit	2

The receiver output messages are listed in Table 3.

4.1.2 Message «0x10». Raw measurements

Length (the number of 32 bit words): 4 + 8*Nsat.

Rate: 1 or 5 times per second in accordance with receiver output data rate.

© R&D Center «Geostar navigation» 2010-12-20

Word #	Type	Unit	Parameter
1, 2	double	s	Time elapsed since UTC 00h 00min 00s January 1st 2008
3	int		Reserved
4	int		The number of SVs for which measurements are transmitted (NSat)
5…12	structure		Measurements data for 1st SV
13…20	structure		Measurements data for 2nd SV
...			...
-3+8*NSat …4+8*NSat	structure		Measurements data for NSatth SV

Structure of measurements data (structure):

Word #	Type	Units	Parameter
1	int		Channel identifier (see below)
2 (16 MSBs)	short	rad	Elevation angle (resolution 0.001rad)
2 (16 LSBs)	short	rad	Azimuth (resolution 0.001rad)
3, 4	double	m	Pseudorange
5, 6	double	m/s	Pseudorange rate
7, 8	double	rad	Carrier phase(1)

Notes:

1. N/A in GeoS-1M

Channel identifier:

Bit #	Parameter
31:16	16 MSBs of Channel status word (see below)
15:11	Channel number (0…23)
10:5	GLONASS: carrier frequency number (range: -7 … +12), complement code GPS: Gold code number (PRN No.) minus 1 (range: 0…31)
4:0	SV system number: GLONASS: 1…24 GPS: 1…32. Code «0» is for system number 32

© R&D Center «Geostar navigation» 2010-12-20

Channel status word:

Bit #	Parameter
15:0	Debug data
17:16	Noise level indicator: 00: normal 10: below threshold 11: above threshold
18	Signal power detect: 0: no 1: yes
19	PLL and DLL lock detect: 0: unlocked 1: locked
20	Frame synchronization flag: 0: no sync 1: sync achieved
21	Time extracted from navigation data: 0: not available 1: available
22	Navigation data frame valid flag: 0: not valid 1: valid
23	Bit synchronization flag: 0: no sync 1: sync achieved
25:24	Signal level estimate: 00: strong 01: more than normal 10: less than normal 11: weak
26	Ephemerides extracted from navigation data: 0: no 1: yes
27	Using SV in fix: 0: no 1: yes
28	Reserved
29	Reserved
30	Satellite system: 0: GLONASS 1: GPS
31	Reserved

4.1.3 Message «0x11». GPS sub-frame data

Length: 12.

Rate: once per 6 seconds; transmitted by the channel that tracks GPS SV.

© R&D Center «Geostar navigation» 2010-12-20

Word #	Type	Units	Parameter
1	u_int		Channel identifier (4.1.2)
2	u_int	s	GPS sub-frame arrival time (time since 00h 00min 00s of current day corresponded to reception of the first string of sub-frame). Resolution 1/200s
3	u_int		Word #1 (30 LSBs). If Hamming code is OK, then relevant bits are «0»
4	u_int		Word #2
…			…
12	u_int		Word #10 (MSBs)

4.1.4 Message «0x12». GLONASS sub-frame data

Length: 8.

Rate: once per 2 seconds; transmitted by the channel which tracks GLONASS SV.

Word #	Type	Units	Parameter
1	u_int		Channel identifier (4.1.2)
2	u_int	s	GLONASS sub-frame arrival time (time since 00h 00min 00s of current day corresponded to reception of the first string of sub-frame). Resolution 1/200s
3	u_int		Data bits 85…54
4	u_int		Data bits 53…22
5	u_int		Data bits 21…1 (21 MSBs). 11 LSBs are «0»
6	u_int		Result of Hamming code check («0» if no errors found)
7	u_int		String number (1...75)
8	u_int		Time mark code

4.1.5 Message «0x13». ECEF coordinates

Length: 32.

Rate: 1 or 5 times per second in accordance with receiver output data rate.

Word #	Type	Units	Parameter
1, 2	double	m	User X coordinate (WGS-84)

© R&D Center «Geostar navigation» 2010-12-20

3, 4	double	m	User Y coordinate (WGS-84)
5, 6	double	m	User Z coordinate (WGS-84)
7, 8	double	m	Clock shift relative to GPS time scale
9, 10	double	m/s	User velocity on X axis, V_x (WGS-84)
11, 12	double	m/s	User velocity on Y axis, V_Y (WGS-84)
13, 14	double	m/s	User velocity on Z axis, V_Z (WGS-84)
15, 16	double	m/s	Clock drift
17, 18	double		PDOP component on X axis
19, 20	double		PDOP component on Y axis
21, 22	double		PDOP component on Z axis
23, 24	double		TDOP
25, 26	double	m	Clock shift relative to GLONASS time scale
27, 28	double	m	Position accuracy estimate
29, 30	double	s	GPS time
31, 32	double	s	GLONASS time

4.1.6 Message «0x20». Geographic coordinates

Length: 34.

Rate: 1 or 5 times per second in accordance with receiver output data rate.

Word #	Type	Units	Parameter
1, 2	double	s	Time elapsed since UTC 00h 00min 00s January 1st 2008
3, 4	double	rad	Latitude
5, 6	double	rad	Longitude
7, 8	double	m	Height above ellipsoid
9, 10	double	m	Difference between the earth ellipsoid and geoid
11	int		Number of SVs in fix
12	int		Reserved
13, 14	double		GDOP

© R&D Center «Geostar navigation» 2010-12-20

15, 16	double		PDOP
17, 18	double		TDOP
19, 20	double		HDOP
21, 22	double		VDOP
23, 24	double	m/s	Smoothed clock drift
25, 26	double	m	Smoothed clock shift relative to GPS time scale
27, 28	double	m	Smoothed clock shift relative to GLONASS time scale
29	int		Position fix valid flag: 0: fix valid otherwise: fix not valid
30	int		Reserved
31, 32	double	m/s	Speed over ground
33, 34	double	rad	Course

4.1.7 Message «0x21». Current receiver telemetry

Length: 3.

Rate: once per second.

Word #	Type	Units	Parameter
1	u_int		Receiver status word (see below)
2	u_int	s	Receiver time since last restart
3 (16 MSBs)	u_short		Number of SVs tracked
3 (16 LSBs)	u_short		Number of SVs in fix

Receiver status word (here and herein):

Bit #	Parameter
0	Reserved
1	Reserved
2	Position fix availability flag: 0: no fix 1: fix available
3	2D fix indicator: 0: 3D 1: 2D

© R&D Center «Geostar navigation» 2010-12-20

4	Reserved
5	Indicator of use of combined constellation in position fix: 0: no 1: yes
6	Reserved
7	Reserved
8	Almanacs available: 0: no 1: yes
9	Reserved
10	PPS valid flag: 0: PPS not valid (not available or out of control) 1: PPS valid
11	Indicator that DR is enabled by solution: 0: no 1: yes
13:12	Satellite constellation: 0: combined 1: GPS only 2: GLONASS only
14	2D fix enable bit: 0: disabled 1: enabled
15	Coordinates hold mode: 0: no 1: yes
16	Indicator that DR is enabled by the user: 0: disabled 1: enabled
17	Reserved
18	Dynamic filter enable bit: 0: disabled 1: enabled
19	Reserved
20	Output data rate indicator: 0: 5Hz 1: 1Hz
21	Reserved
22	Antenna power telemetry bit: 0: failed 1: OK
23	Frequency synthesizer telemetry bit: 0: failed 1: OK
24	DR position fix indicator: 0: no 1: yes
25	Reserved
26	Use of dynamic filter indicator: 0: no filtering

© R&D Center «Geostar navigation» 2010-12-20

	1: filter used
27	Receiver identifier: 0: GeoS-1 1: GeoS-1M
29:28	Receiver operation mode: 0: normal 1: test 2: FW update
30	Reserved
31	Reserved

4.1.8 Message «0x22». SVs in view

Length: 1 + 3*NSat.

Rate: once per second.

Word #	Type	Units	Parameter
1	int		The number of SVs for which the data is transmitted (NSat)
2…4	structure		Data for 1st SV in view
...			...
-1+3*NSat …1+3*NSat	structure		Data for Nsatth SV in view

Data for SV in view (structure):

Word #	Type	Units	Parameter
1	int		Channel identifier (4.1.2)
2 (16 MSBs)	short	rad	Elevation angle (resolution 0.001rad)
2 (16 LSBs)	short	rad	Azimuth (resolution 0.001rad)
3 (16 MSBs)	short	dbHz	SNR (resolution 0.1dBHz)
3 (16 LSBs)	short		Number of receiver channel (0…23) that trackes given SV. Code «0xFFFF» is transmitted if SV is not in track

4.1.9 Message «0x3E». Receiver power-up message

Length: 3.

Rate: once in 2 seconds after receiver power-up.

© R&D Center «Geostar navigation» 2010-12-20

Word #	Type	Units	Parameter
1	u_int		NVSRAM integrity check results: the number of blocks with failed data. If no failed data found then code «0» is transmitted
2	u_int		Code of UTC read out from NVSRAM. Transmitted code «0» means failure
3	u_int		Code of UTC read out from RTC

4.1.10 Message «0x3F». Negative acknowledge

Length: 2.

Word #	Type	Units	Parameter
1	u_int		ID of the message which caused error
2	u_int		Error cause: 1: incorrect check sum 2: incorrect number of data words 3: incorrect message ID 4: incorrect parameter value

4.1.11 Message «0x40». Response to Set initial parameters

Length: 12.

Response to input message «0x40».

Word #	Type	Units	Parameter
1	u_int	s	Time elapsed since UTC 00h 00min 00s January 1st 2008. Resolution 1s
2	int	s	Local time shift relative to UTC
3, 4	double	m	User X coordinate (WGS-84)
5, 6	double	m	User Y coordinate (WGS-84)
7, 8	double	m	User Z coordinate (WGS-84)
9	int		Code of clock drift. Resolution 0.1m/s
10	int		Reserved
11,12	double	m	GLONASS-GPS time shift

© R&D Center «Geostar navigation» 2010-12-20

4.1.12 Message «0x41». Response to Set serial ports parameters

Length: 4.

Response to input message «0x41».

Word #	Type	Units	Parameter
1	u_int		Port number: 0: Port #0 1: Port #1
2	u_int		Baud rate (bit/s): 0: 4800 1: 9600 2: 19200 3: 38400 4: 57600 5: 115200
3	u_int		Number of stop bits: 0: 1 1: 2
4	u_int		Parity bit: 0: no 1: even 2: odd 3: always «0» 4: always «1»

4.1.13 Message «0x42». Response to Set receiver operation mode

Length: 3.

Response to input message «0x42».

Word #	Type	Units	Parameter
1	u_int		2D fix: 0: disabled 1: enabled
2	u_int		Satellite system: 0: combined 1: GPS only 2: GLONASS only
3	u_int		Coordinates hold mode: 0: no 1: yes

© R&D Center «Geostar navigation» 2010-12-20

4.1.14 Message «0x43». Response to Set navigation task solution parameters

Length: 5.

Response to input message «0x43».

Word #	Type	Units	Parameter
1	u_int		GDOP mask. Resolution 1e-1
2	u_int	degree	Elevation angle mask
3	u_int	s	DR duration. Resolution 1s, range 1…5s
4	u_int		DR mode: 0: disabled 1: enabled
5	u_int		Dynamic filter: 0: disabled 1: enabled

4.1.15 Message «0x44». Response to Set output data rate

Length: 1.

Response to input message «0x44».

Word #	Type	Units	Parameter
1	u_int		Output data rate: 0: 5Hz 1: 1Hz

4.1.16 Message «0x46». Response to Assign data protocol to communication port

Length: 1.

Response to input message «0x46».

Word #	Type	Units	Parameter
1	u_int		Assignment between data protocol and communication port: 0: Port #0 outputs binary data; Port #1 - NMEA data 1: Port #0 outputs NMEA data, Port #1 - binary data

© R&D Center «Geostar navigation» 2010-12-20

4.1.17 Message «0x48». Response to Set GPS almanac

Length: 20.

Response to input message «0x48».

Word #	Type	Units	Parameter
1, 2	double	semi-circles	Mean Anomaly at Reference Time (M_0)
3, 4	double		Eccentricity (e)
5, 6	double	$m^{1/2}$	Square Root of the Semi-Major Axis ($\sqrt{A}$)
7, 8	double	semi-circles	Longitude of Ascending Node of Orbit Plane at Weekly Epoch ($OMEGA_0$)
9, 10	double	semi-circles	Inclination Angle at Reference Time (i_0)
11, 12	double	semi-circles	Argument of Perigee (ω)
13, 14	double	semi-circles/s	Rate of Right Ascension (OMEGADOT)
15, 16	double	s	Polinomial coefficient a_{f0}
17, 18	double	s/s	Polinomial coefficient a_{f1}
19	int	s	Reference Time Almanac, bits 21:0 (t_{oa}) and Number of Week (WN_a) to which the t_{oa} is referenced (bits 31:22)
20 (16 MSBs)	short		SV health
20 (16 LSBs)	u_short		PRN number (PRN No.)

4.1.18 Message «0x49». Response to Set GLONASS almanac

Length: 18.

Response to input message «0x49».

Word #	Type	Units	Parameter
1, 2	double		Eccentricity (ε_n^A)
3, 4	double	s/orbital period^2	Rate of change of Draconian period of n^A SV ($\dot{T}_n^A$)
5, 6	double	semi-circles	Argument of perigee of n^A SV (ω_n^A)
7, 8	double	s/orbital period	Correction to the mean value of Draconian period of the n^A SV (ΔT_n^A)
9, 10	double	s	Time of the first ascending node passage of n^A SV within N^A day ($t_{\lambda n}^A$)

© R&D Center «Geostar navigation» 2010-12-20

11, 12	double	semi-circles	Longitude of the first ascending node of n^A SV orbit in PZ-90 within N^A day (λ_n^A)
13, 14	double	semi-circles	Correction to the mean value of inclination of n^A SV (Δi_n^A)
15, 16	double	s	Coarse value of n^A SV time correction to GLONASS time (τ_n^A)
17 (16 MSBs)	u_short	day	Calendar day number within the four-year period beginning since the leap year (N^A)
17 (16 LSBs)	u_short		SV system number (n^A)
18 (16 MSBs)	short		Carrier frequency number of RF signal transmitted by n^A SV (H_n^A)
18 (16 LSBs)	u_short		«Unhealthy» flag C_n^A (bit 15), type of GLONASS SV M_n^A (bits 0 and 1)

4.1.19 Message «0x4A». Response to Set GPS ephemerides

Length: 45.

Response to input message «0x4A».

Word #	Type	Units	Parameter
1	int	s	Receiver time at the moment of ephemeris reception (code «0» is UTC 00h 00min 00s January 1st 2008)
2	int		IODE
3, 4	double	semi-circles	Mean Anomaly (M_0)
5, 6	double	semi-circles/s	Mean Motion Difference From Computed Value (Δn)
7, 8	double		Eccentricity (e)
9, 10	double	$m^{1/2}$	Square Root of the Semi-Major Axis ($\sqrt{A}$)
11, 12	double	semi-circles	Longitude of Ascending Node of Orbit Plane at Weekly Epoch ($OMEGA_0$)
13, 14	double	semi-circles	Inclination Angle at Reference Time (i_0)
15, 16	double	semi-circles	Argument of Perigee (ω)
17, 18	double	semi-circles/s	Rate of Right Ascension (OMEGADOT)
19, 20	double	semi-circles/s	Rate of Inclination Angle ($IDOT$)
21, 22	double	rad	Amplitude of the Cosine Harmonic Correction Term to the Argument of Latitude (C_{uc})
23, 24	double	rad	Amplitude of the Sine Harmonic Correction Term to the Argument of Latitude (C_{us})
25, 26	double	m	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius (C_{rc})

© R&D Center «Geostar navigation» 2010-12-20

27, 28	double	m	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius (C_{rs})
29, 30	double	rad	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination (C_{ic})
31, 32	double	rad	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination (C_{is})
33	int	s	Reference Time Ephemerides (t_{oe})
34	int	s	Clock data reference time (t_{oc})
35 (16 MSBs)	short		Code on L2
35 (16 LSBs)	short	week	Week No.
36 (16 MSBs)	short		SV accuracy
36 (16 LSBs)	short		IODC
37, 38	double	s	T_{GD}
39, 40	double	s/s^2	Polinomial coefficient a_{f2}
41, 42	double	s/s	Polinomial coefficient a_{f1}
43, 44	double	s	Polinomial coefficient a_{f0}
45 (16 MSBs)	short		SV health
45 (16 LSBs)	short		PRN number (PRN No.)

4.1.20 Message «0x4B». Response to Set GLONASS ephemerides

Length: 32.

Response to input message «0x4B».

Word #	Type	Units	Parameter
1	int		Receiver time at the moment of ephemeris reception (code «0» is UTC 00h 00min 00s January 1st 2008)
2	int	minute	Index of a time interval within current day according to UTC(SU) + 03 hours 00 min (t_b)
3, 4	double	km	SV X coordinate in PZ-90 at the instant t_b (x_n (t_b))
5, 6	double	km	SV Y coordinate in PZ-90 at the instant t_b (y_n (t_b))
7, 8	double	km	SV Z coordinate in PZ-90 at the instant t_b (z_n (t_b))
9, 10	double	km/s	SV velocity on X axis in PZ-90 at the instant t_b ($\dot{x}_n$ (t_b))
11, 12	double	km/s	SV velocity on Y axis in PZ-90 at the instant t_b ($\dot{y}_n$ (t_b))

© R&D Center «Geostar navigation» 2010-12-20

13, 14	double	km/s	SV velocity on Z axis in PZ-90 at the instant t_b $(\dot{z}_n(t_b))$
15, 16	double	km/s^2	SV acceleration on X axis in PZ-90 at the instant t_b $(\ddot{x}_n(t_b))$
17, 18	double	km/s^2	SV acceleration on Y axis in PZ-90 at the instant t_b $(\ddot{y}_n(t_b))$
19, 20	double	km/s^2	SV acceleration on Z axis in PZ-90 at the instant t_b $(\ddot{z}_n(t_b))$
21, 22	double		Relative deviation of predicted carrier frequency value of SV from nominal value ($\gamma_n(t_b)$)
23, 24	double	s	Correction to SV time relative to GLONASS time ($\tau_n(t_b)$)
25, 26	double	s	GLONASS time scale correction to UTC(SU) time (τ_c)
27, 28	double	s	Correction of GPS time relative to GLONASS (τ_{GPS})
29 (16 MSBs)	double	day	Age of ephemerides ($E_n^Э$)
29 (16 LSBs)	double	day	Age of time correction and frequency deviation data (E_n^T)
30 (16 MSBs)	int		Parameter of predicted SV user range accuracy (F_T)
30 (16 LSBs)	int	day	Sum of four-year period and day number within the four-year period expressed in days $1461*N_4 + (N^A - 1)$
31 (16 MSBs)	short	day	Calendar day number within the four-year period beginning since the leap year (N^A)
31 (16 LSBs)	short		SV system number (n^A)

32 (16 MSBs)	short		SV «health» flag:
			// bit 0: l_n from string 2 of ephemerides
			// bit 1: l_n from string 3 of ephemerides
			// bit 2: l_n from string 5 of ephemerides
			// bit 4: l_n from string 7 of almanac
			// bit 5: l_n from string 9 of almanac
			// bit 6: l_n from string 11 of almanac
			// bit 7: l_n from string 13 of almanac
			// bit 8: l_n from string 15 of almanac
			// bit 9: inverse C_n^A of almanac

32 (16 LSBs)	short		Flags:
			// bits 1:0: flag P1
			// bits 3:2: flag Bn
			// bit 4: flag P2
			// bit 5: flag P3
			// bits 7:6: flag P
			// bit 8: flag P4
			// bits 11:9: reserved
			// bits 13:12: flag M

4.1.21 Message «0x4C». Response to Set PPS parameters

Length: 5.

© R&D Center «Geostar navigation» 2010-12-20

Response to input message «0x4C».

Word #	Type	Units	Parameter
1	u_int		PPS output: 0: disabled 1: enabled
2	u_int		PPS polarity: 0: positive 1: negative
3	u_int		PPS synchronization time scale: 0: GPS 1: UTC 2: GLONASS 3: UTC(SU)
4	u_int		PPS duration code. Resolution: 1/19 200 000s. Value range: 0.01…2ms
5	u_int		PPS shift code. Resolution: 1/614 400 000s. Value range: ±1ms

4.1.22 Message «0x4D». Response to Enable/disable SV in position fix

Length: 2.

Response to input message «0x4D».

Word #	Type	Units	Parameter
1	u_int		Code of SV number: • GPS: 0 – SV #1, 1 – SV #2, … , 31 – SV #32 • GLONASS: 32 – SV #1, 33 – SV #2, … , 55 – SV #24
2	u_int		SV status: 0: SV disabled for use in position fix 1: SV enabled for use in position fix

4.1.23 Message «0x4E». Response to Enable/disable NMEA messages

Length: 2.

Response to input message «0x4E».

Word #	Type	Units	Parameter
1	u_int		NMEA messages masks. 0: message disabled 1: message enabled bit 0: GGA mask bit 1: GSA mask

© R&D Center «Geostar navigation» 2010-12-20

			bit 2: GSV mask bit 3: RMC mask bit 4: VTG mask bit 5: GLL mask bit 6: ZDA mask
2	u_int		NMEA talker ID select: 0: always «GP» 1: according to 0183 v3.01 standard («GP», «GN», or «GL»)

4.1.24 Message «0x4F». Response to Enable/disable binary messages

Length: 2.

Response to input message «0x4F».

Word #	Type	Units	Parameter
1	u_int		Automatically generated binary messages masks: 0: message disabled 1: message enabled bit 0: message «0x00» mask bit 1: message «0x01» mask bit 2: message «0x02» mask … bit 31: message «0x1F» mask
2	u_int		Mask of the receiver channels transmitted debug data (message «0x04»)(1)

Notes:

1. Debug data is not available to user and bits 15:0 in word #1 and word #2 are «0»

4.1.25 Message «0x80». Response to Query initial parameters

Length: 12.

Response to input message «0x80». Data content is identical to that of message «0x40». Note that word #1 in this message is current receiver time.

4.1.26 Message «0x81». Response to Query serial ports parameters

Length: 4.

Response to input message «0x81». Data content is identical to that of message «0x41».

© R&D Center «Geostar navigation» 2010-12-20

4.1.27 Message «0x82». Response to Query receiver operation mode

Length: 3.
Response to input message «0x82». Data content is identical to that of message «0x42».

4.1.28 Message «0x83». Response to Query navigation task solution parameters

Length: 5.
Response to input message «0x83». Data content is identical to that of message «0x43».

4.1.29 Message «0x84». Response to Query output data rate

Length: 1.
Response to input message «0x84». Data content is identical to that of message «0x44».

4.1.30 Message «0x86». Response to Query data protocol assignment to communication port

Length: 1.
Response to input message «0x86». Data content is identical to that of message «0x46».

4.1.31 Message «0x88». Response to Query GPS almanac

Length: 20.
Response to input message «0x88». Data content is identical to that of message «0x48».

4.1.32 Message «0x89». Response to Query GLONASS almanac

Length: 18.
Response to input message «0x89». Data content is identical to that of message «0x49».

© R&D Center «Geostar navigation» 2010-12-20

4.1.33 Message «0x8A». Response to Query GPS ephemerides

Length: 45.
Response to input message «0x8A». Data content is identical to that of message «0x4A».

4.1.34 Message «0x8B». Response to Query GLONASS ephemerides

Length: 32.
Response to input message «0x8B». Data content is identical to that of message «0x4B».

4.1.35 Message «0x8C». Response to Query PPS parameters

Length: 5.
Response to input message «0x8C». Data content is identical to that of message «0x4C».

4.1.36 Message «0x8D». Response to Query enable/disable status of the SV in position fix

Length: 2.
Response to input message «0x8D». Data content is identical to that of message «0x4D».

4.1.37 Message «0x8E». Response to Query enabled NMEA mesaages

Length: 1.
Response to input message «0x8E». Data content is identical to that of message «0x4E».

4.1.38 Message «0x8F». Response to Query enabled binary messages

Length: 2.
Response to input message «0x8F». Data content is identical to that of message «0x4F».

4.1.39 Message «0xC1». Response to Request FW version command

Length: 1.

© R&D Center «Geostar navigation» 2010-12-20

Response to input message «0xC1».

Word #	Type	Units	Parameter
1 (16 MSBs)	u_short		FW version, high word
1 (16 LSBs)	u_short		FW version, low word
2	u_int		FW version date: bits 4…0: day bits 8…5: month bits 23…9: year
3	u_int		Receiver status word, bits 30 and 31 (4.1.7)
4	u_int		Receiver S/N: high byte: alphabetical code 3 low bytes: numerical code

4.1.40 Message «0xC2». Response to Restart receiver command

Length: 1.

Response to input message «0xC2».

Word #	Type	Units	Parameter
1	u_int		Restart and restore default settings code: • bit 0: indicator that ephemerides in NVSRAM cleared 0: ephemerides cleared 1: ephemerides not cleared • bit 1: indicator that almanacs in NVSRAM are cleared 0: almanacs cleared 1: almanacs not cleared • bit 2: restore default FW settings indicator 0: receiver is operating with current FW settings 1: receiver is operating with default FW settings Combination of bits 0 and 1 indicate different restart modes the receiver operates in: code «0» indicates hot start, code «1» - warm start, code «3» - cold start

4.1.41 Message «0xC3». Response to Store parameters to Flash command

Length: 1.

Response to input message «0xC3».

© R&D Center «Geostar navigation» 2010-12-20

Word #	Type	Units	Parameter
1	u_int		Store parameters to Flash indicator: 0: parameters have been stored successfully 1: parameters have not been stored

4.2. Input Messages

4.2.1 Message Format

“P”:8 “S”:8 “G”:8 “G”:8 <ncmd:16> <ndat:16> <dat1:32, …, datN:32> <cs:32>

- “PSGG”: message preamble (32 bits)
- <ncmd>: message number (16 bits)
- <ndat>: the number of 32-bit words in data fields (16 bits)
- <dat1, dat2, …, datN>: data fields (32-bit words); the number of words is defined by <ndat> parameter
- <cs>: check sum (32 bits); calculated as exclusive OR of all data fields.

The receiver output messages are listed in Table 4.

4.2.2 Message «0x40». Set initial parameters

Length: 12.
Data content is identical to that of output message «0x40».

4.2.3 Message «0x41». Set serial ports parameters

Message length: 4.
Data content is identical to that of output message «0x41».

4.2.4 Message «0x42». Set receiver operation mode

Message length: 3.
Data content is identical to that of output message «0x42».

© R&D Center «Geostar navigation» 2010-12-20

4.2.5 Message «0x43». Set navigation task solution parameters

Message length: 5.
Data content is identical to that of output message «0x43».

4.2.6 Message «0x44». Set output data rate

Message length: 1.
Data content is identical to that of output message «0x44».

4.2.7 Message «0x46». Assign data protocol to communication port

Message length: 1.
Data content is identical to that of output message «0x46».

4.2.8 Message «0x48». Set GPS almanac

Message length: 20.
Data content is identical to that of output message «0x48».

4.2.9 Message «0x49». Set GLONASS almanac

Message length: 18.
Data content is identical to that of output message «0x49».

4.2.10 Message «0x4A». Set GPS ephemerides

Message length: 45.
Data content is identical to that of output message «0x4A».

4.2.11 Message «0x4B». Set GLONASS ephemerides

Message length: 32.
Data content is identical to that of output message «0x4B».

© R&D Center «Geostar navigation» 2010-12-20

4.2.12 Message «0x4C». Set PPS parameters

Message length: 5.
Data content is identical to that of output message «0x4C».

4.2.13 Message «0x4D». Enable/disable SV in position fix

Message length: 2.
Data content is identical to that of output message «0x4D».

4.2.14 Message «0x4E». Enable/disable NMEA messages

Message length: 2.
Data content is identical to that of output message «0x4E».

4.2.15 Message «0x4F». Enable/disable binary messages

Message length: 2.
Data content is identical to that of output message «0x4F».

4.2.16 Message «0x80». Query initial parameters

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.17 Message «0x81». Query serial ports parameters

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Port number parameters of which are requested: 0: Port #0 1: Port #1

© R&D Center «Geostar navigation» 2010-12-20

4.2.18 Message «0x82». Query receiver operation mode

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.19 Message «0x83». Query navigation task solution parameters

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.20 Message «0x84». Query output data rate

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.21 Message «0x86». Query data protocol assignment to communication port

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.22 Message «0x88». Query GPS almanac

Message length: 1.

© R&D Center «Geostar navigation» 2010-12-20

Word #	Type	Units	Parameter
1	u_int		GPS SV system number (1…32)

4.2.23 Message «0x89». Query GLONASS almanac

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		GLONASS SV system number (1…24)

4.2.24 Message «0x8A». Query GPS ephemerides

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		GPS SV system number (1…32)

4.2.25 Message «0x4B». Query GLONASS ephemerides

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		GLONASS SV system number (1…24)

4.2.26 Message «0x8C». Query PPS parameters

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

© R&D Center «Geostar navigation» 2010-12-20

4.2.27 Message «0x8D». Query enable/disable status of the SV in position fix

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Code of SV number: • GPS: 0 – SV #1, 1 – SV #2, … , 31 – SV #32 • GLONASS: 32 – SV #1, 33 – SV #2, … , 55 – SV #24

4.2.28 Message «0x8E». Query enabled NMEA messages

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.29 Message «0x8F». Query enabled binary messages

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

4.2.30 Message «0xC1». Request FW version

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

© R&D Center «Geostar navigation» 2010-12-20

4.2.31 Message «0xC2». Restart receiver

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Restart and restore default settings code: • bit 0: clear ephemerides in NVSRAM command 0: clear ephemerides 1: has no effect • bit 1: clear almanacs in NVSRAM command 0: clear almanac 1: has no effect • bit 2: restore default FW settings command 0: has no effect (receiver is operating with current FW settings) 1: restore default settings Combination of bits 0 and 1 causes different receiver restart modes: code «0» initiates hot start, code «1» - warm start, code «3» - cold start

4.2.32 Message «0xC3». Store parameters to Flash

Message length: 1.

Word #	Type	Units	Parameter
1	u_int		Any value

© R&D Center «Geostar navigation» 2010-12-20

5. Appendix B. NMEA Data Description

The following provides a summary explanation of the NMEA approved parametric sentence structure:

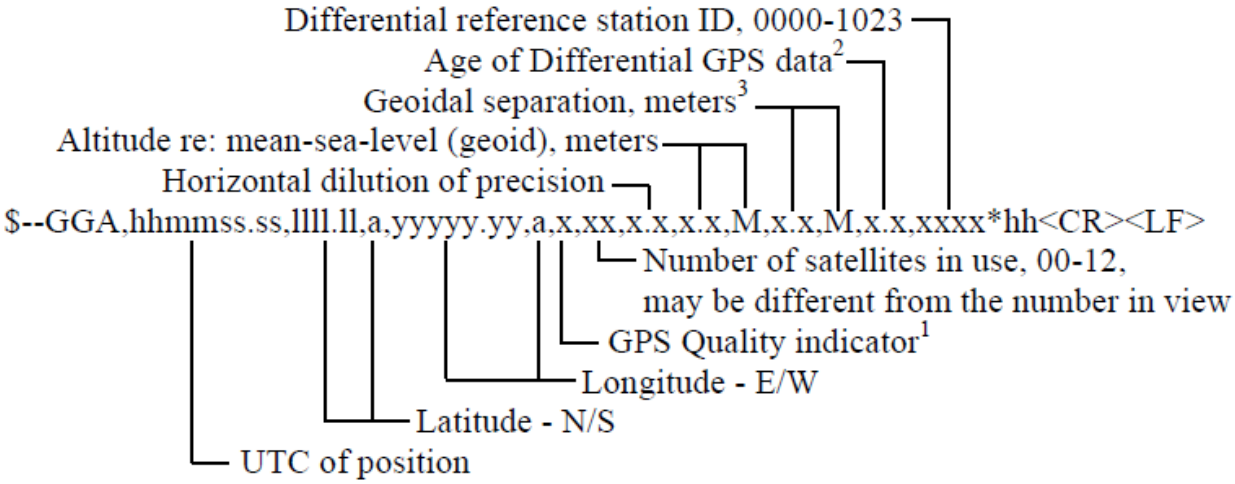
$aaccc,c--c*hh<CR><LF>

1. ”$” Start of Sentence
2. ”aaccc” Address Field. Alphanumeric characters identifying type of TALKER, and Sentence Formatter. The first two characters identify the TALKER. The last three are the Sentence Formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate readouts by users.
3. “,” Field delimiter. Starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field
4. ”c--c” Data Sentence block. Follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by 3rd and subsequent characters of the address field (the "Sentence Formatter"). Data fields may be of variable length and are preceded by delimiters ","
5. ”*” Checksum Delimiter. Follows last data field of the sentence. It indicates that the following two alphanumeric characters show the HEX value of the Checksum.
6. ”hh” Checksum Field. The absolute value calculated by exclusive-OR'ing the 8 data bits (no start bits or stop bits) of each character in the Sentence, between, but excluding "$" and "*". The hexadecimal value of the most significant and least significant 4 bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first. The Checksum field is required in all transmitted sentences. Example: $GPGSV,5,5,17,77,71,048,53*43.
7. <CR><LF> Terminates Sentence.

© R&D Center «Geostar navigation» 2010-12-20

5.1. GGA: Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.


Differential reference station ID, 0000-1023
Age of Differential GPS data[2]
Geoidal separation, meters[3]
Altitude re: mean-sea-level (geoid), meters
Horizontal dilution of precision
$--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>
Number of satellites in use, 00-12,
may be different from the number in view
GPS Quality indicator[1]
Longitude - E/W
Latitude - N/S
UTC of position

Notes:

1) GPS Quality Indicator:

0 = Fix not available or invalid
1 = GPS SPS Mode, fix valid
2 = Differential GPS, SPS Mode, fix valid
3 = GPS PPS Mode, fix valid
4 = Real Time Kinematic. System used in RTK mode with fixed integers
5 = Float RTK. Satellite system used in RTK mode, floating integers
6 = Estimated (dead reckoning) Mode
7 = Manual Input Mode
8 = Simulator Mode

The GPS Quality Indicator field shall not be a null field.

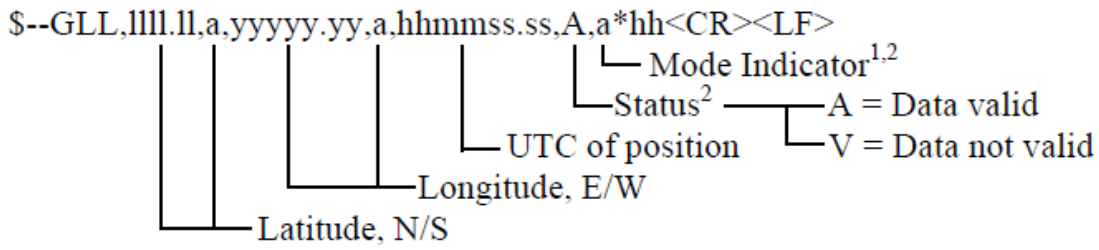
2) Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is not used

3) Geoidal Separation: the difference between the WGS-84 earth ellipsoid surface and mean-sea-level

© R&D Center «Geostar navigation» 2010-12-20

5.2. GLL: Geographic Position - Latitude/Longitude

Latitude and Longitude of vessel position, time of position fix and status.



Notes:

1) Positioning system Mode Indicator:

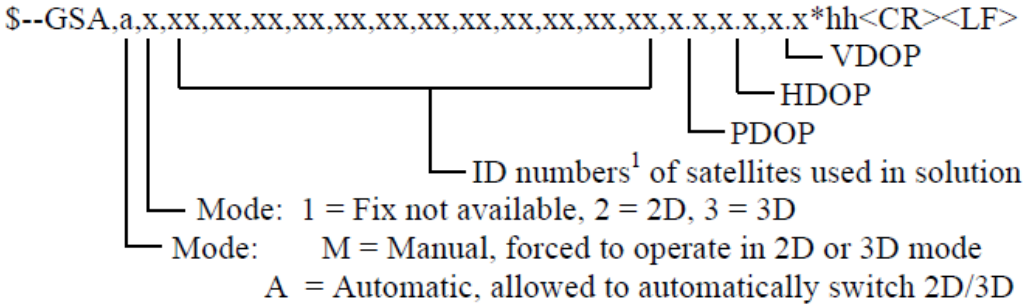
A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

2) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to V=Invalid for all values of Indicator mode except for A=Autonomous and D=Differential. The positioning system Mode Indicator and Status fields shall not be null fields.

5.3. GSA: GNSS DOP and Active Satellites

GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence, and DOP values.

If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the DOP values pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the reported position solution multiple GSA sentences are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GSA sentences shall have talker ID GN, to indicate that the satellites are used in a combined solution and each shall have the PDOP, HDOP and VDOP for the combined satellites used in the position.


$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>
VDOP
HDOP
PDOP
ID numbers[1] of satellites used in solution
Mode: 1 = Fix not available, 2 = 2D, 3 = 3D
Mode: M = Manual, forced to operate in 2D or 3D mode
A = Automatic, allowed to automatically switch 2D/3D

© R&D Center «Geostar navigation» 2010-12-20

Notes:

Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a. GPS satellites are identified by their PRN numbers, which range from 1 to 32.

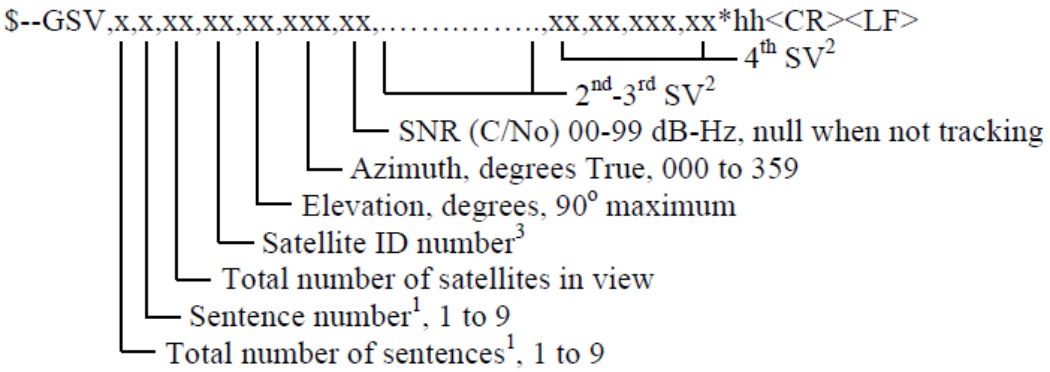
b. The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.

c. The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+satellite slot number. The slot numbers are 1 through 24 for the full constellation of 24 satellites, this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

5.4. GSV: GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission. Total number of sentences being transmitted and the number of the sentence being transmitted are indicated in the first two fields.

If multiple GPS, GLONASS, etc. satellites are in view, use separate GSV sentences with talker ID GP to show the GPS satellites in view and talker GL to show the GLONASS satellites in view, etc. The GN identifier shall not be used with this sentence.


$--GSV,x,x,xx,xx,xx,xxx,xx,……..,xx,xx,xxx,xx*hh<CR><LF>
4th SV2
2nd-3rd SV2
SNR (C/No) 00-99 dB-Hz, null when not tracking
Azimuth, degrees True, 000 to 359
Elevation, degrees, 90° maximum
Satellite ID number3
Total number of satellites in view
Sentence number1, 1 to 9
Total number of sentences1, 1 to 9

Notes:

1) Satellite information may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The first field specifies the total number of sentences, minimum value 1. The second field identifies the order of this sentence (sentence number), minimum value 1. For efficiency it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

© R&D Center «Geostar navigation» 2010-12-20

2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per sentence. Null fields are not required for unused sets when less than four sets are transmitted.

3) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

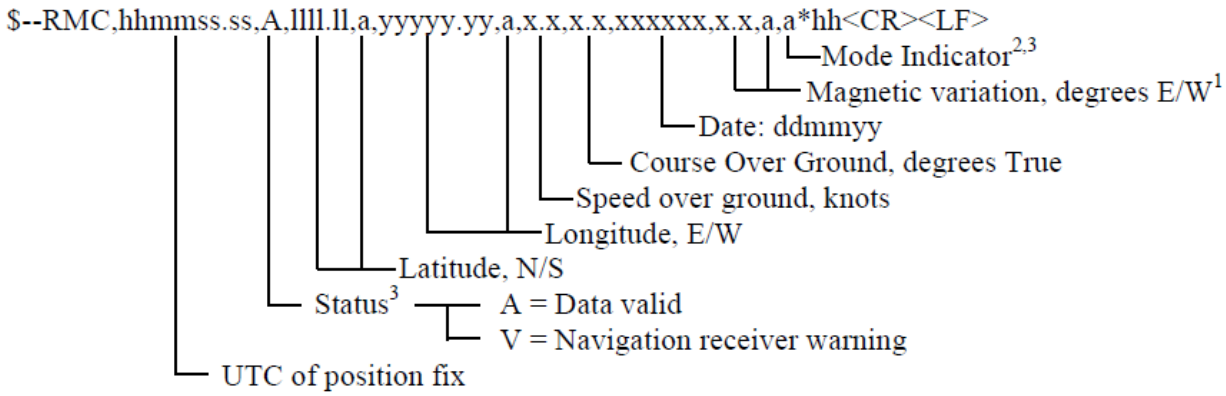
a. GPS satellites are identified by their PRN numbers, which range from 1 to 32.

b. The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.

c. The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+satellite slot number. The slot numbers are 1 through 24 for the full constellation of 24 satellites, this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

5.5. RMC: Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.



Notes:

1) Easterly variation (E) subtracts from True course. Westerly variation (W) adds to True course

2) Positioning system Mode Indicator:

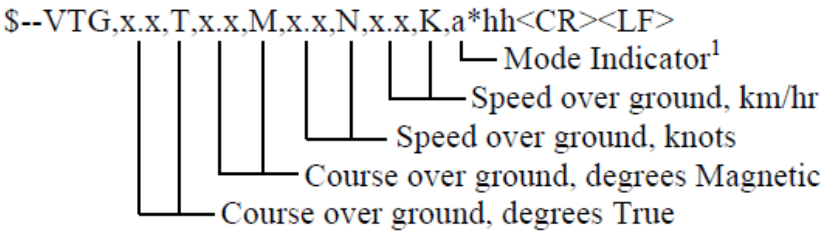
A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

© R&D Center «Geostar navigation» 2010-12-20

3) The positioning system Mode Indicator field supplements the positioning system Status field, the Status field shall be set to V=Invalid for all values of Indicator mode except for A=Autonomous and D=Differential. The positioning system Mode Indicator and Status fields shall not be null fields.

5.6. VTG: Course Over Ground and Ground Speed

The actual course and speed relative to the ground.



Notes:

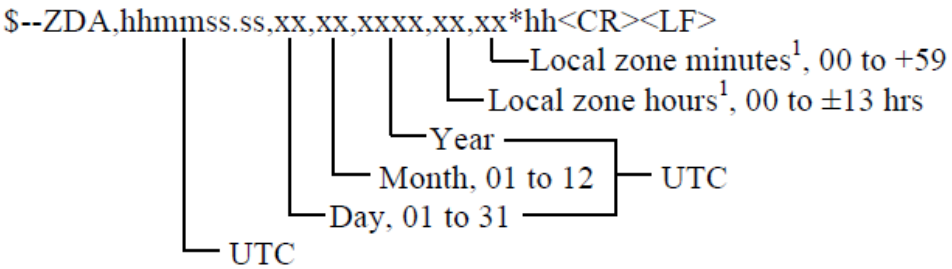
1) Positioning system Mode Indicator:

A = Autonomous mode
D = Differential mode
E = Estimated (dead reckoning) mode
M = Manual input mode
S = Simulator mode
N = Data not valid

The positioning system Mode Indicator shall not be a null field.

5.7. ZDA: Time & Date

UTC, day, month, year and local time zone.



Notes:

1) Local time zone is the magnitude of hours plus the magnitude of minutes added, with the sign of local zone hours, to local time to obtain UTC. Local zone is generally negative for East longitudes with local exceptions near the International Date Line.

© R&D Center «Geostar navigation» 2010-12-20

5.8. SWPROT: Switch to Binary Protocol

The command switches the receiver port working with binary data to NMEA.

Format: $GPSGG,SWPROT*75.

5.9. SAVEFL: Save Parameters to Flash

The command initiates saving FW settings and satellites almanacs to receiver's Flash.

Format: $GPSGG,SAVEFL*63

5.10. CSTART: Cold Start

The command initiates receiver's cold start.

Format: $GPSGG,CSTART*6B

5.11. WSTART: Warm Start

The command initiates receiver's warm start.

Format: $GPSGG,WSTART*7F

5.12. HSTART: Hot Start

The command initiates receiver's hot start.

Format: $GPSGG,HSTART*60

© R&D Center «Geostar navigation» 2010-12-20

6. Appendix C. GeoS-1M Connection Board: Summary

The GeoS-1M Connection Board is the auxiliary hardware which function is to connect GeoS-1M receiver board to external environment for demonstrating receiver functionality. Top view of Connection Board is shown in Fig. 24.

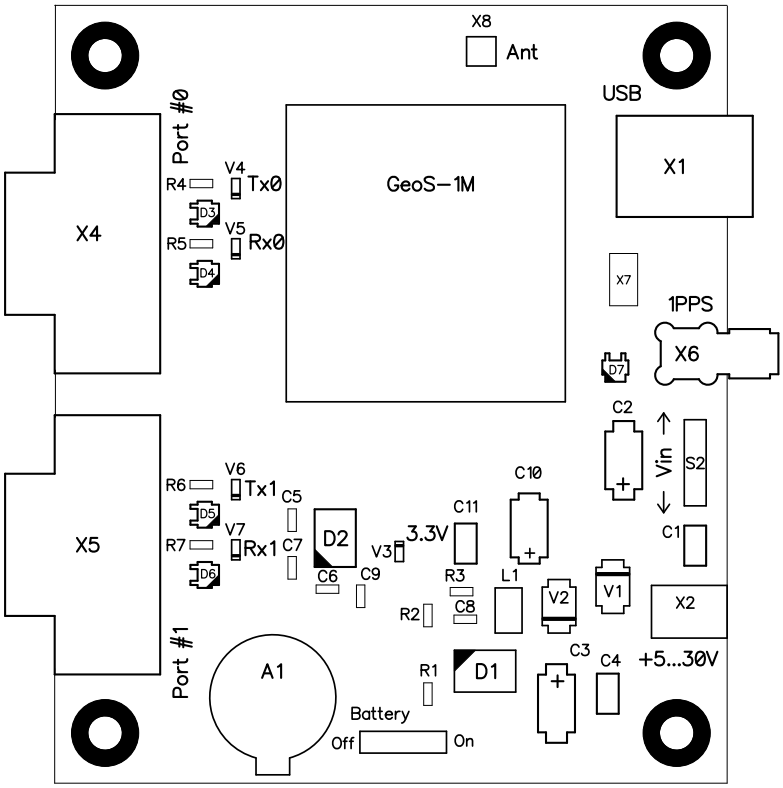


Fig. 24. GeoS-1 Connection Board top view

The main functions of Connection Board are:

- To generate receiver main supply voltage 3.3V from unregulated 5…30V DC input
- To provide external backup power to the receiver
- For serial RS232 ports, to convert LVTTL levels to/from levels complying with EIA-232
- To provide connections to external antenna («**Ant**» connector, MMCX female) and computer COM ports («**Port #0**» and «**Port #1**» connectors)
- To provide 1PPS output at SMA connector
- To indicate status of 3.3V and activity on serial port lines.

The receiver board is soldered to Connection Board as shown in Fig. 25.

© R&D Center «Geostar navigation» 2010-12-20

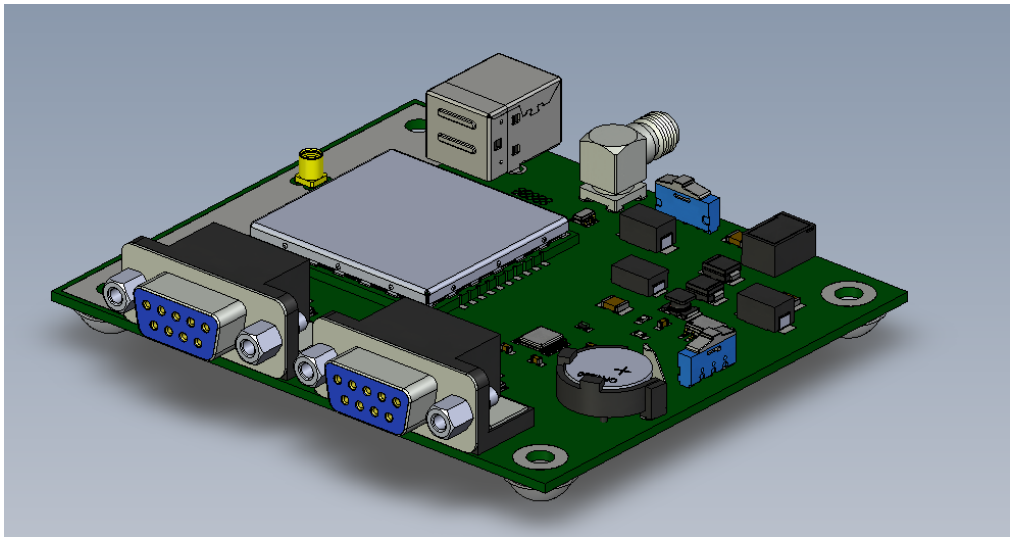


Fig. 25. Receiver and Connection Board assembly

Unregulated supply voltage 5…30V is applied to X2 power jack. S2 switch «Vin» selects the input voltage to be either 5…30V or USB 5.0V. To set 5…30V, S2 slider shall be directed to X2. If 3.3V power is OK, relevant LED indicator «3.3V» will light.

The Connection Board has embedded backup battery CR1220 connected to S1 switch. Move S1 slider to «On» for applying the battery power to the receiver; move the slider to «Off» for disconnecting the battery.

1PPS signal is available at X6 RF connector (SMA female). The LED indicators «Tx0», «Rx0» and «Tx1», «Rx1» show the lines activity of Port #0 and Port #1, respectively.

The Connection Board outline dimensions (in mm) are shown in Fig. 26.

© R&D Center «Geostar navigation» 2010-12-20

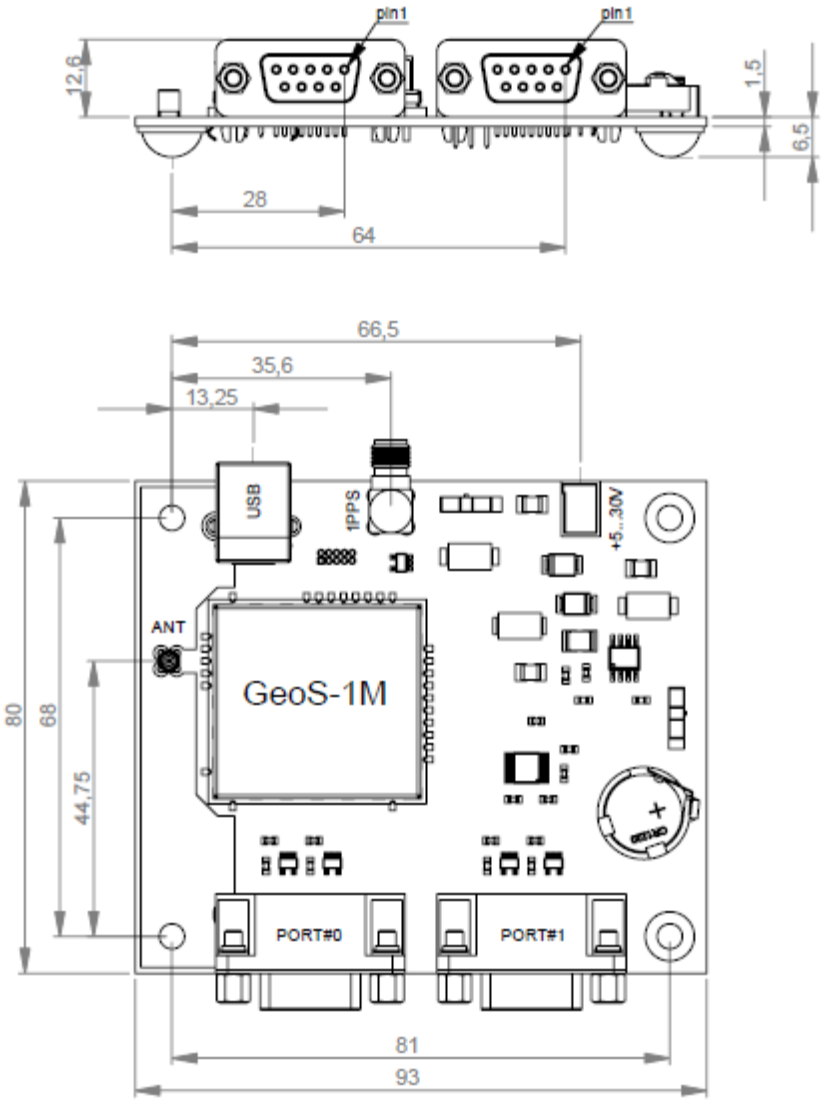


Fig. 26. Outline dimensions of GeoS-1 Connection Board

© R&D Center «Geostar navigation» 2010-12-20